THE 2016 AFRICAN DOMAIN NAME SYSTEM MARKET STUDY

FINAL REPORT

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Acknowledgements

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AFRICA DOMAIN NAME SYSTEM MARKET STUDY

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1 EXECUTIVE SUMMARY

This market study into the domain name system in Africa was commissioned to, among other things:

- Highlight the strengths and weaknesses in the Domain Name Service (DNS) sector in Africa;
- Develop recommendations on how to advance the industry to better exploit the opportunities available and to address identified challenges; and
- Explore options for establishing an observatory to continuously monitor the growth, development and emerging needs of the DNS market in Africa.

The Internet Corporation for Assigned Names and Numbers (ICANN) includes 54 countries in its "Africa" region – including all independent countries on the continent and several neighbouring islands. Accessing consistently reliable statistical information from all these countries is inevitably challenging – given the size of the continent, language differences and the huge disparities between and within countries in relation to, for example, levels of development, literacy and skills, infrastructure roll out and access to resources. These disparities are mirrored in some ways in the membership of the African Network Information Centre (AfriNIC), the African Regional Internet Registry (RIR) for Internet number resources. It has, for example, only one member in Eritrea compared to 643 in South Africa.

This is a baseline study. No such study has, to the authors' knowledge, ever been carried out on the Domain Name Market for the entire African continent. Later studies will be able to make comparisons with these results in order to evaluate growth and progress[1].

1.1 Methodology

To address the challenges of collecting reliable information, the research team utilised a range of mechanisms to access the information required to fulfil the objectives set including an online survey, zone file analysis of country code and generic top level domain (ccTLD and gTLD) registries, interviews with selected key stakeholders and extensive desktop research. In addition, a number of the research team members have decades of experience in the DNS industry in Africa, and their insights informed some of our conclusions.

[1] A study on the Middle East and Adjoining Countries (MEAC) did include several North African Arabic countries: https://www.icann.org/en/system/files/files/meac-dns-study-26feb16-en.pdf

Some 1 400 potential participants in the study were identified through reviewing membership of AfriNIC, registrations by the Internet Assigned Numbers Authority (IANA), country code top-level domain registries (ccTLD), Google searches for registrars of domains and memberships of individual country Internet exchange points (IXPs), Internet Service Provider Associations (ISPAs), Internet Society (ISOC) chapters and personal knowledge. All participants were specifically targeted and sent personal links to an online survey by a total of 40 team members.

The online survey tool included six different questionnaires for identified target groups (Registry, Registrar, Registrant, Regulator, Reseller and IXP Manager) translated into four languages (English, French, Portuguese and Arabic). A response rate of 22% was received (a total of 308 questionnaires were completed by 209 targeted respondents, noting that some completed more than one questionnaire)[2]. The response rate varied between countries – from no completed questionnaires received from targeted entities in 22 countries (41%) to 31% of the targeted respondents answering an average of 1.8 questionnaires each in for example Sudan - one of the 32 countries (59%) from which questionnaires were received. Responses were received from all six identified stakeholder groups, all six AfriNIC regions[3] and all four language groups.

1.2 The African Ecosystem

It is important to contextualise the DNS market in relation to the total African Internet and communications ecosystem. Key indicators in relation to this include the following:

- Africa is a very diverse region. By example of the 20 lowest ranked countries in the 2016 Networked Readiness Report, 18 are in Africa.[4] And yet of the 7 Top Movers in the Global Information Technology Report 2016 – 3 are in Africa.[5]
- Africa is lagging behind other regions in relation to Internet access with an average penetration of 28.7% compared to a world average of 50.1%[6]. This overall penetration level however masks big differences between countries in Africa with Internet access varying from 1% in Eritrea to 68% in Kenya.
- Access is predominantly via mobile devices.
- Backbone fibre networks are gradually spreading across most African countries, and all coastal countries except Guinea Bissau & Eritrea have access to at least one submarine fibre cable and most countries have at least two. There are over 1 million kilometres of

[2] Note that this reflects the number of completed questionnaires submitted. Fifteen percent of those sent links to questionnaires completed the questionnaire.
[3] Indian Ocean, Eastern, Western, Central, Northern and Southern African regions. See https://www.afrinic.net/en/about/service-region
[4] http://reports.weforum.org/global-information-technology-report-2016/networked-readiness-index/
[5] http://reports.weforum.org/global-information-technology-report-2016/infographics-and-shareables/
[6] http://www.internetworldstats.com/stats.htm as of June 2016

terrestrial fibre installed and cross-border fibre is increasing so that almost all countries will be connected to their neighbours by fibre by 2018.

- Local access remains problematic in almost all African countries. Outside of South Africa, major deployments of metro fibre have largely focused on capital cities, particularly Accra, Dar es Salaam, Kigali, Harare, Kampala, Lomé, Lusaka and Nairobi. Wi-Fi deployments follow a similar distribution, often preceding FTTH[7]. However, even in these cities, the majority of people still rely on mobile access.
- While broadband uptake in Africa has been increasing, high Internet access costs continue to be the biggest factor limiting usage in most countries. The Alliance for Affordable Internet[8] (A4AI) estimates that for only 500 MB of monthly data — enough to watch just two minutes of video a day — the average African has to pay over 15% of his monthly income, compared with 1% by the average European. This, together with the fact that African Internet access is primarily via mobile devices, results in a low demand for domain names.
- Growth in local Internet infrastructure is speeding up, with 36 fully operational IXPs[9] in 26 countries and an increasing number of fully-fledged data centres being built. In terms of IP resources, Africa accounts for 2% of IPv4 and 1% of IPv6 addresses out of the total global usage. The research further confirmed that there is a correlation between the number of IXPs in a country and the maturity of the local industry: i.e. countries with more IXPs have a more mature DNS market and respondents to the survey identified the absence of local IXPs as one of the barriers to development of the DNS market.
- An analysis of the volumes of web page content indexed by Google found that 75% of 400 million African pages indexed are in just seven African countries - South Africa, Kenya, Zimbabwe, Uganda, Nigeria, Egypt and Morocco.
- In relation to assessing the extent of offshore versus on continent hosting, the research team was unfortunately only able to access a very limited number of Zone Files and Registrar database extracts. This data indicated that about 10 countries have well developed local hosting facilities.

1.3 African DNS Market

The African continent top level DNS address space consists of 54 top level country code ccTLDs, (of which one, Southern Sudan (SS) is not yet delegated) plus five Internationalised Domain

[7] FTTH = Fibre To The Home
[8] http://a4ai.org/affordability-report/report/2015/
[9] IXP = Internet Exchange Point

Names (IDNs): Egypt (مصر), Algeria (الجزائر), Tunisia (تونس), Sudan (سودان) and Morocco (المغرب) as well as three city codes (.CAPETOWN, .DURBAN and .JOBURG). ICANN recently delegated the .AFRICA domain to the South African administrator, the ZA Central Registry (ZACR), and registrations will be fully open in July, 2017. Note that according to responses to the survey, the use of IDNs is reasonably widespread. Analysis of the responses shows that at least 46% of Registries offer non-Latin scripts and more than a third of Registrars (34%) do.

Data from May 2017 indicates that a total of just over 3.5 million domains are active under the African ccTLDs[10]. There are about 1.4 million registrations in the gTLDs by African entities. Key findings of the research are summarised below.

3.5 m ccTLDs
1.4 m gTLDs
in May 2017

- Approximately 1% of gTLD domains are registered by Africans.
- Over the last six months (November 2016 – May 2017), African ccTLD domains have increased by 21%[11]. However, almost all (93%) of this increase was in fact in the four Freenom 'domain hack' countries[12]. Nevertheless, the statistics quoted in the remainder of this Report are based on the November 2016 figure of 2.9 million ccTLD domain names.
- Registrations by Africans of gTLD domains total approximately 1.4 million, the bulk of which is ~1.2 million .COM domains.
- The research indicates that high access costs, the lack of infrastructure and the fact that African Internet access is primarily via mobile devices results in a lower demand for domain names than elsewhere. This was confirmed by responses to the survey, with respondents citing high prices as the biggest barrier to the development of the DNS market in most African countries followed by lack of infrastructure.
- Other broader issues identified as high barriers by respondents include poor dependability of Internet connections and unclear or restrictive policy and regulatory environments. In addition, the research analysed the relationship, if any, between a country's ranking in relation to levels of freedom (using rankings by Freedom House and IIAG) and the number of domains registered. According to this, citizens of "free" countries in Africa register some 22 times as many domains as citizens in countries ranked "not free".
- Domain name registration by African entities takes place mainly in countries where the local hosting industry and web development sector has developed sufficiently to create

[10] http://research.domaintools.com/statistics/tld-counts/ Figure updated as per 2017/05/06
[11] As recorded by DomainTools
[12] See section 6.3.3

demand for local domains, i.e. mostly in South Africa, Egypt, Mauritius, Nigeria, Kenya, Zimbabwe, Uganda, Tunisia and Morocco. The research also confirmed zero or low levels of local hosting in a significant majority of countries in the region: 41 countries hosted over 95% of their gTLD domains outside Africa.

- The research found 51 functioning ccTLD Registries, with South Sudan (SS) not yet delegated and Eritrea (ER) and the Comoros (KM), which each have just over 100 domains, but have no apparent method of registering new domains via the Internet, also non-functional.
- Compared to other regions, Africa has a very small number of ICANN accredited Registrars. In total, there are only 11 ICANN accredited registrars in the region[13] - four in South Africa, two in Morocco and one each in Burundi, Ghana, Nigeria, Senegal and Tunisia out of a global total of 2,143. However, there are many more Registrars than this actually active in Africa, with 450 Registrars accredited by the ZACR alone, for example. Unless specified otherwise, the term "accredited Registrar" means a Registrar accredited by the relevant ccTLD Registry in the remainder of this report. In reality, 26 countries have only one Registrar (typically the Registry itself), whereas 13 countries are fully competitive, use EPP and have multiple Registrars, with the remaining 14 being partly competitive and Southern Sudan not yet delegated. This was a factor in the number of ccTLD domains sold, although it is also true that successful markets attract more Registrars.
- For the Registrant Market, this market review identified over 5 million African ccTLD and gTLD domains. This equates to some 4.4 domains / 1000 population, whereas some commentators state that 100 – 300 domains / 1000 population is the norm in Europe.
- In this regard it should be noted that there are a number of African countries (11 are most popular) that have unexpectedly high numbers of domain registrations due, it seems, to what are known as 'domain hacks' (where domains are utilised by entities or individuals not from these countries because the ccTLD forms part of an intended word or similar unexpected uses). These occur because these countries have domain names that cost little or nothing to register or are attractive for special purposes where registering a short or a common word in the ccTLD has more relevance than registration in the more popular gTLDs such as .COM or .NET. In addition these

[13] https://www.icann.org/registrar-reports/accredited-list.html & https://www.internic.net/alpha.html

countries have non-restrictive rules that allow registration of domains from entities located outside the country.

- The DNS market roughly equates to a total value of about USD $38 million per annum for African ccTLD domain names alone.[14] At least 25% of this is likely to accrue to the international registrars and the remaining USD $29 million would be import or local revenue generated by the ccTLDs and Registrars. About 73% of the total annual revenue on the continent is made by just ten countries (South Africa, Morocco, Nigeria, Zimbabwe, Egypt, Tanzania, Libya, Somalia, Cameroon and Ivory Coast). Including the gTLD domains with an African connection increases the total annual value of the industry to some USD $52 million.
- Most of the African ccTLDs are available for registration for offshore entities without the requirement for a local presence. In 15 countries there is a requirement for some form of local legal presence (corporate or individual) in order to register a domain name: Algeria, Angola, Benin, Burkina Faso, Cap Verde, Egypt, Gambia, Guinea, Liberia, Mauritania, Niger, Senegal, Tanzania, Tunisia and Zambia. In a few countries, including Kenya, there is an additional requirement for Registrars to be locally based, but not Registrants.
- The study also considered the likely growth in the market. In all markets except South Africa (which is mature) there has been significant growth in the number of African domains registered by top-level domain registrars (e.g. .COM, .ORG and .INFO domains) as infrastructure rollout has increased in many countries, albeit off a low base. The research expects this trend to continue – projecting an annual overall growth of 33%

This suggests significant growth opportunities for local providers in individual countries – noting that 91% of the Registrants that responded to the online survey said they preferred to deal with local Registrars.

1.4 Success factors

A "Country DNS Success Index" was developed by the researchers to rank countries in relation to the health of their DNS markets. The index used a range of factors to "score" countries including the number of domains registered under the ccTLD; the number of gTLD domains identified as having an African Registrant; the number of web pages indexed by Google; price of registration;

[14] This is calculated by multiplying the total number of domains registered in each country by the minimum registration fee for domains in each African ccTLD and includes the gTLD domain names registered by Africans.

number of Registrars; number of locally hosted websites; the presence of one or more functioning IXPs; and Internet usage as a percentage of the population.

In terms of this, South Africa ranked overall highest of all countries, followed by Kenya, Nigeria, Zimbabwe and Tunisia.

By assessing common factors in countries that scored highly and the characteristics of those that scored particularly low in relation to the index, researchers were able to identify a number of critical success factors for ccTLD Registries, namely: -

- Infrastructure of sufficient expanse and quality to facilitate access to the Internet is available;
- There is a general digital awareness among the population with sufficient literacy – both conventional and digital[15];
- Conducive policy, regulatory and governance frameworks are in place;
- Payment gateways have been put in place to ensure easy payment of fees. Note that responses to the online survey confirmed the need for easy payment mechanisms, with both registrars and registrants indicating they preferred paying by bank transfer than by credit/debit card. Respondents also ranked the absence of easy payment methods as one of the key barriers to growth in the DNS market;
- Fees for registering a domain should be cost-based (but not zero)[16];
- Registration is comparatively easy to complete (including simple automated systems in place for registration and fast payment mechanisms). Note that respondents to the user experience section of the questionnaire listed slow processing time as the third biggest challenge to development of the DNS market and the quality of technical support as the fifth most significant difficulty;
- Information on how to register a domain is easily available, promoting confidence and therefore facilitating a critical mass of domain names;
- Training of industry players in the technical aspects of good DNS management and implementation, as well as in content creation; and
- There must be an effective business model and a marketing / consumer awareness strategy.

[15] See section 5.3.1: "A set of skills that allows a user to not only access the Internet, but to navigate websites, and evaluate and create information through digital devices"
[16] See Section 6.3.3 for an explanation of "domain hacks".

1.5 Recommendations

Research recommendations on strategies to put in place to advance the DNS industry in Africa include proposals on addressing issues in the wider environment that inhibit growth and suggestions specific to the DNS market. These are summarised below.

1.5.1 Infrastructure

The availability of the infrastructure necessary to enable uptake and usage of the Internet, of broadband, and of Internet-enabled goods and services is clearly critical. Without the availability of infrastructure and access to service providers, there is no DNS market.

Without infrastructure and service providers, there is no DNS market.

The development of local infrastructure also includes the provision of IXPs and data centres. Also vital is the roll-out of fibre networks, likely initially in the more affluent urban centres (and supported by a clear set of universal access and service interventions to obviate the creation of a new digital divide), together with cross-border fibre and the provision of sufficient undersea cable capacity.

Countries that do not have any local hosting facilities must build IXPs, data centres and fibre networks – but should ensure in doing so that underlying issues such as the willingness of network operators to interconnect are addressed. Building an IXP is neither technically difficult nor is it expensive. When local network operators sell access to "the Internet", they are actually selling access to everyone else's networks, including their competitors. It's thus essential that they agree to cooperate sufficiently to interconnect and exchange traffic. If they don't do so locally, they will do so overseas, often at higher cost and always at lower performance. Once a functioning IXP exists, data centres will become not only viable but essential. This then leads to the growth of a local hosting industry, with the resulting social and economic benefits.

Registries, Registrars and Registrants should therefore engage with operators, regulators and policy-makers in support of measures that will: promote the provision of fixed and mobile networks and services; ensure the reduction of prices, in particular data pricing; and support a range of universal access and service interventions to promote Internet uptake by disadvantaged individuals and communities in under-serviced areas.

1.5.2 Internet Service Demand

Without a sufficient level of digital awareness on the part of individuals and communities, the uptake and usage of the Internet and the online services it enables will remain either stagnant or grow slowly. Similarly, in the absence of an environment where online services - such as e-commerce (online shopping, online banking and more), e-government (online access to

government services, including e-filing of tax returns), e-learning and more - are prevalent, it is difficult to envisage a high degree of local DNS uptake. Local online activity stimulates the local DNS market and drives Internet demand.

Ensuring and protecting both online freedom of expression and online privacy and security is also key. Such interventions will encourage the creation of local content, and act as an industry driver.

An effective business model and a marketing and consumer awareness strategy about domain name registrations, with appropriate regulatory and governance mechanisms, must be put in place. Registries, Registrars and Registrants should therefore engage with policy-makers and with a range of other entities to promote the development of and demand for the fullest possible range of online goods and services.

1.5.3 Policy and Regulation

In the absence of a fully reformed ICT environment - with full and dynamic competition, a strong and independent Regulator supported by effective legislation, where the incumbent state-owned provider has been privatised and exposed to the exigencies of a competitive market - it is hard to see how the DNS market can grow quickly and dynamically. An effective ICT environment requires both regulatory certainty and a forward-looking approach.

Country policies must ensure separate roles for the Registry, Registrar and Registrant (the "3R Model"). There must in addition be a sufficient number of Registrars - at least 20 – to ensure adequate competition as well as a simple, quick and cheap dispute resolution system (Alternative Dispute Resolution) implemented and supported by appropriate legislation. Policies to promote e-commerce must be developed in all countries and sufficient investment in implementing these policies must be made.

The general ease of doing business in a country inevitably affects the DNS market as well, and possibilities relating to e-commerce. There is a need to address factors identified in international and regional studies on the ease of doing business in Africa and in individual countries.

Competition among local Internet Service Providers is essential, because it drives down prices and increases innovation. The competitors need to interconnect at an IXP to grow the local Internet economy.

Registries and Registrants should therefore develop the necessary capacity to engage with policy-makers and regulators to ensure that conducive policy, regulatory and governance frameworks are in place going forward.

1.5.4 Local Content

Registration of (especially local) domain names with websites containing local content fosters the growth of the economy in terms of the construction of data centres to accommodate the machines hosting African websites, the IXPs to interchange local data, the telecommunications (especially fibre) infrastructure to interconnect these locations, and, of course, the need for skilled people to design, implement, manage and maintain these infrastructure elements. A second set of skills is required to develop, update and maintain suitable content.

The lack of relevant local content in languages spoken in individual countries must be addressed as this is crucial to driving uptake and penetration – and therefore to development of the DNS market. E-government is a crucial means for increasing local content and the drive to ensure government services are accessible and available online is essential.

1.5.5 Inhibiting Factors

Laws and practices inhibiting freedom of expression online must be scrutinised as these may inhibit content creation and hence demand for websites, blogs and domain names.

Rules governing who may register a domain and how to do so should be as simple as possible and easily available. For example, rules in place in some countries requiring domain names to match the business / personal[17] name of the entity should be removed. Similarly those countries requiring registrants to have a legal presence in their country should review these with the aim of removing such requirements. Requirements, if any, relating to compliance prior to registration of all intellectual property rights laws[18] should be removed and rules should rather focus on addressing violations through alternative dispute resolution mechanisms after registration.

1.5.6 Registry Specific Recommendations

The Registry should have a website with functioning and easy to use registry landing pages. It should provide simple and automatic procedures for registration fulfilment and payment, and must include payment by bank transfer, credit card and/or mobile money as an option.

Fees for registering a domain should be cost-based (but not zero)[19].

[17] Guinea Bissau for example requires this according to information gathered through the research
[18] Zimbabwe for example requires that applicants prove compliance with intellectual property laws before registration
[19] Where domains are "given away" as discussed in Section 6.3.3, the benefit to the country is severely limited

2 INTRODUCTION

This project was initiated by the Internet Corporation for Assigned Names and Numbers (ICANN) which commissioned the South African Communications Forum (SACF), in association with the Association for Progressive Communications (APC) and independent consultants to identify and define the strengths and weaknesses in the DNS industry ecosystem in Africa, and to develop recommendations on how to advance the industry and bring it closer to the opportunities available. The aims of the study were to assess:

- The development of an online data gathering platform and detailed questionnaires to gather relevant information about the African DNS sector;
- Regional / country-based breakdown of domain name registrations, including ccTLD and gTLDs registrations (to the extent possible given the difficulties of identifying African registrants of gTLDs); and registrations by different stakeholder groups (e.g. business, governments, NGOs, education, individuals, etc.);
- The growth of African domain name registrations and the current ecosystem of local registrars and resellers for ccTLDs and gTLDs.
- The user experience at local registrars and resellers (e.g. support for local languages, payment gateways, IDN support and level of automation).
- The overall potential for growth of the domain name industry in Africa and factors that constrain take-up of domain names (e.g. awareness, infrastructure, policy and / or regulation, processes, payment gateways).
- Best practices that have had an impact in domain name market growth, including those related to business models, regulatory and governance mechanisms, consumer awareness, amongst others.
- Current awareness of Premium Domain Names and strategies on how to develop this market.
- Methods for setting up a DNS observatory in Africa.

The beneficiaries of this project are ultimately the citizens of Africa and the domain name industry in Africa as a whole. The key DNS industry stakeholders and other groups consulted for this report were:

- Domain name holders/registrants
- Domain name administrators: Registries, Registrars, Resellers
- National Policy Makers
- National Regulatory Authorities (NRAs) for ICT/Telecom/Communications
- Regional institutions, e.g. the African Union Commission, Regional Economic Communities (RECs), and other Economic Development and Educational Institutions
- Internet Exchange Points (IXPs)
- NGOs and Civil Society Groups
- Well-known African ICT industry representatives

The SACF Team Members attended a number of African Internet-related events[20] and interacted with DNS industry role-players, gathering both quantitative and qualitative data through conducting surveys, interviews and meetings in order to obtain the required data and information.

In addition, a variety of secondary research data was also obtained. The following were the chief data sources:

- IANA
- The institutions responsible for management of the ccTLD Registries
- National Regulatory Authorities (NRAs)
- AfriNIC
- AfTLD
- Internet Service Providers (ISPs)
- International registrars, such as Afilias and 101Domains
- Internet industry analysts such as DomainTools and Telegeography

ICANN conducted two DNS studies similar to this study for the Latin American and Caribbean Region and the Middle East and Adjoining Countries Region. The former was conducted in 2015 to set the domain name industry and registration data in the wider context of the region's Internet development, Internet usage patterns and user preferences, the region's hosting

[20] These included the African DNS Forum 2016 (MA), ICANN 55 (MA) & 56 (FI), ICANN Workshop on Emerging Issues in the DNS Industry (ZW), AIS / AfriNIC 24 (BW) and AfriNIC 25 (MU)

industry and the importance of local language content. Subsequently, it draws on relevant benchmarks and best practices developed within the global ccTLD environment, and leads to some suggested actions that may stimulate wider uptake. It considered a total of 26 countries, and provided detailed results for 13 of them.

The LAC study was commissioned in 2016 to identify and define the strengths and weaknesses in the industry ecosystem within the region and to develop recommendations on how to advance the industry and bring it closer to the opportunities available. A total of 40 countries are considered to be in the region, and the report again focussed on 13 of them.

In the same line, ICANN commissioned the African DNS Study in 2016 to conduct a market analysis in the Domain Name Service (DNS) industry and then provide recommendations on how to develop the industry. This study considered all 54 countries in the Africa region and provided detailed results for 20 of them. Accessing consistently reliable statistical information from all these countries is inevitably challenging; not only because of the size of the continent, but also the language differences, levels of development, literacy and skills, infrastructure roll out and access to resources. The study team developed an online tool to gather as much information as possible from wide and varied respondents including all stakeholders, then automated the analysis process to improve the quality of the data and the results coming from the system. This methodology allows the owner of the study, i.e. ICANN, to update the study in future and get many interesting histogram findings by repeating the distribution of the survey tool and running the analysis again. This capability matches well with the DNS Observatory concept mooted in section 10.

3 PROJECT BACKGROUND

In June 2012, the African Internet community had a historic meeting in Prague (ICANN 44) that was chaired by Steve Crocker (Chairman of ICANN Board), Fadi Chehade (ICANN's incoming CEO at that time) and Moctar Yedaly from the African Union Commission. The outcome was a new approach to Africa that would focus on the following action lines:

- Develop a framework for ICANN's Africa strategy
- Support a stronger presence for ICANN in Africa
- Increase Africa's participation in ICANN

The Africa Strategy Working Group (ASWG) was set up during the meeting, and it developed the Africa Strategy document (2012 - 2015) which was presented during ICANN 49 in Toronto. The document became the cornerstone of ICANN's engagement in Africa.

In 2014, the Africa Strategy Review team convened again alongside AfriNIC 21 in Mauritius and revised the document as per the new ICANN 2016-2020 strategic plan, deemed the ICANN Africa Strategy Version 2.0 2016 – 2020[21]. This revised document was adopted at ICANN 52 (February 2015) after presentation to the community.

Two of the strategic projects (No 15 & 16) identified in the revised strategic plan[22] were:

- Commit and conduct a study on the business feasibility of growing the DNS industry in Africa
- Commission an observatory to develop new indices for DNS industry growth in Africa

This study aimed to support the implementation of these key recommendations and projects in the Africa Strategic plan, as expressly identified and approved by the ASWG and the African Internet community.

3.1 Project Objectives

In summary, the overall objectives of this study were to identify the strengths and weaknesses in the DNS industry ecosystem in Africa, and to develop recommendations on how to advance the industry and bring it closer to the opportunities available. The study also aimed to support

[21] https://www.slideshare.net/AfriNIC/01-pierre-d
[22] https://singapore52.icann.org/en/schedule/tue-africa-strategy/presentation-africa-strategy-plan-10feb15-en

setting up an observatory that can continuously monitor the growth, development and emerging needs of the DNS market in Africa.

4 METHODOLOGY

To maximise the impact of the resources available for the project, the data gathering process was automated as much as possible by means of an online survey tool that could also ultimately form a key part of an African DNS Observatory (see Section 9.2 below). In addition, using software tools developed for the project, DNS zone files were analysed, along with extracts from Registrars' databases and other related information extracted from Registrar websites and industry analysts.

Acquiring data on the DNS industry for all 54 African countries, with widely differing levels of economic, social, political, telecommunications and Internet development was a daunting task. In order to address this, individual team members were each assigned one or more countries for which they acted as the 'country leader'. Country leaders were chosen on the basis of:

- In-country knowledge and contacts;
- Understanding of the Internet in general and the DNS industry in particular;
- Ability to carry out a challenging assignment in a limited time;
- Relevant language skills.

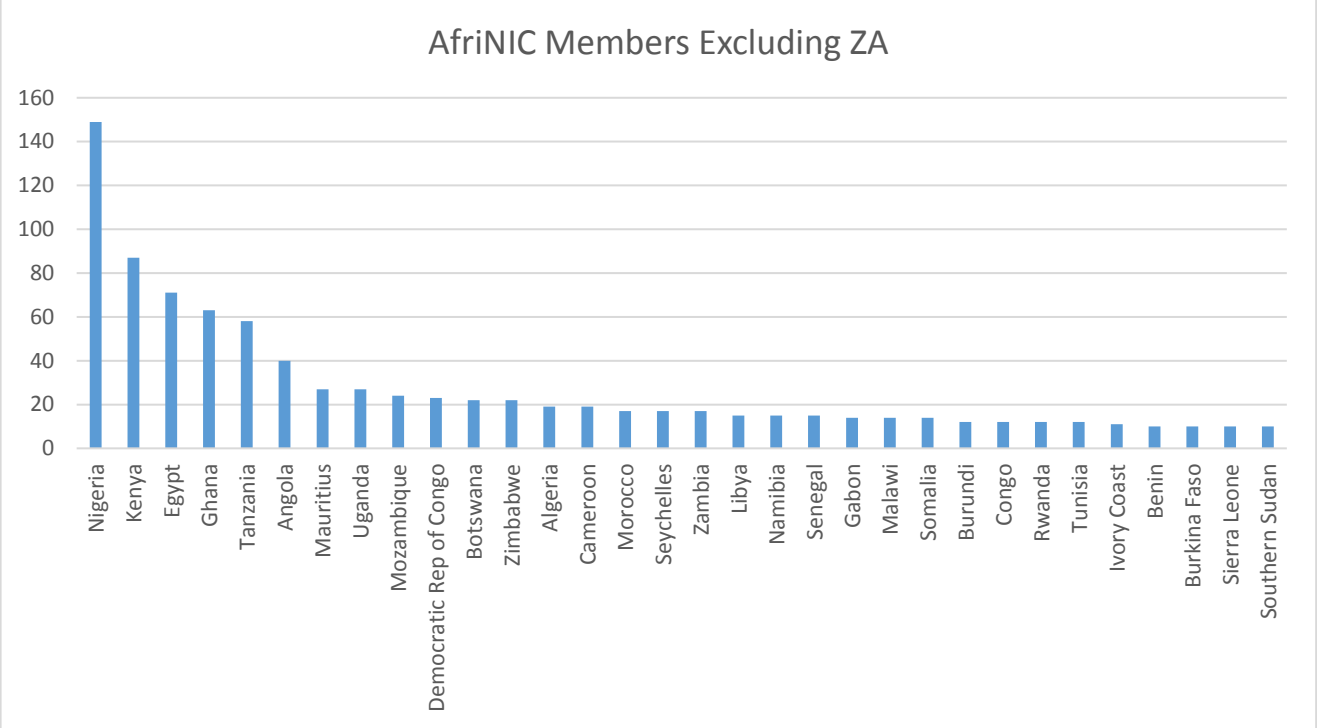
4.1 Development of Targets for Data Gathering

Initially, targets for the number of responses per country were based on the numbers of AfriNIC members in each country. AfriNIC members are either entities that use IP addresses and provide them to others, known as Local Internet Registries (LIRs), or they are entities that use IP addresses (and ASNs[23]) for their internal purposes, known as End Sites. AfriNIC members thus include ISPs (LIRs), academic institutions, banks, governments and other business enterprises (End Sites). At the time of the project formulation, AfriNIC reported several data sets, of which the most significant were Local Internet Registries, which mainly list those who supply connectivity to others, and provide other services, including both IP addresses and names. We equated these to Registrars or Resellers. Other members are End Users (now called End Sites), which we equated to Registrants. We set targets for Registries which assumed the typical country had six registries: the ccTLD itself, plus COM.ccTLD, ORG.ccTLD, NET.ccTLD, EDU.ccTLD and AC.ccTLD or equivalent second level domains (2LDs). On this basis, we initially set a target of 1700 respondents to the questionnaire. This was based on as few as 13 potential respondents

[23] Autonomous System Numbers, a globally unique index used to refer to all networks managed by one entity

in very small markets such as Eritrea, which only has one AfriNIC member, to 454 respondents from South Africa, which has 643 AfriNIC members.

Figure 4-1: Countries with at least 10 AfriNIC Members



Countries with 10 or more AfriNIC members are shown in the figure above. The remaining 21 countries each have fewer than 10 members, with the Comoros and Eritrea having a single member each. This AfriNIC membership data indicates that at least 1,639 organisations or individuals are using IP resources in Africa, namely IP addresses and / or ASNs.

Resources were allocated for research in all 54 countries. Those countries which had significantly larger markets, based on AfriNIC membership, required more extensive focus, and are listed in the table below. It is clear from the chart above and the table below that there is significant segmentation in the African DNS market, with some countries having a far larger Internet sector compared to others.

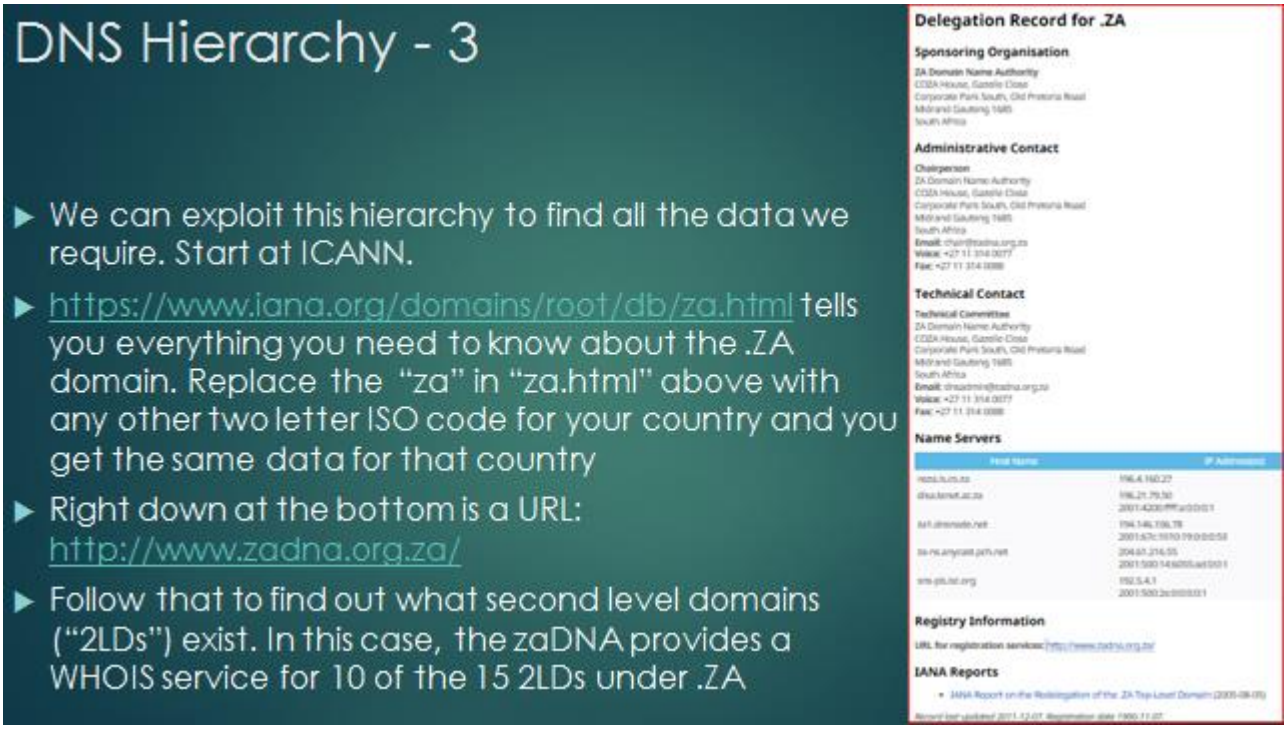
Table 4-1: Large AfriNIC members

Country	AfriNIC members
South Africa	643
Nigeria	149
Kenya	87
Egypt	71
Ghana	63
Tanzania	58

In the period between the first assessment of AfriNIC membership for each country, and when project country leaders began training, AfriNIC removed the details of individual members broken down by country from their website. This was done for privacy protection but made the task considerably harder, as other sources were then needed for Registrar data.

Desktop research, starting at IANA, provided data on the ccTLD for each country, which in turn lead us to the Registrars. In effect, we followed the hierarchical distributed database nature of the Domain Name System itself to identify potential targets for data gathering. A slide from one of the training courses developed for the consultants demonstrates this process in the Figure below.

Figure 4-2: DNS Hierarchy



The DNS industry in Africa was considerably larger than had initially been assumed

As we investigated further, we found that the extent of the DNS industry in Africa was considerably larger than had initially been assumed, at least for some countries. For example, we found that Tunisia had 20 2LDs and that Namibia had 61 Registrars accredited by the ccTLD Registry, while Zimbabwe did not accredit Registrars, but rather had over 70 resellers. On the other hand, some countries had significantly smaller domain name numbers than expected.

Several strands of research were used to come to these conclusions. They included:

- AfriNIC membership, as discussed above;
- IANA, to locate the ccTLD, if not already known;
- Data from the ccTLD registries, many of which publish lists of accredited Registrars;
- Searches on Google for Registrars of domains under a specific ccTLD. This identified many out-of-country Registrars;
- Identification of IXPs in each country, and examination of their members. All those peering at an IXP operate a network, and therefore are Registrants. Many of them are also ISPs, and may therefore be Registrars;

- Similarly, lists of members of ISP Associations and ISOC Chapters were helpful in identifying, primarily, Registrars and Registrants, respectively.

4.2 The Online Survey Tool

A number of existing survey tools were considered, but it was decided that the study's particular requirements – especially the need for multiple languages – required the development of a new platform that could also serve as the basis for an ongoing observatory. As the skills were available within the team, this was carried out in house. In addition, this allowed considerable customisation and ongoing refinement to be applied, which would not have been possible using a third party tool.

The survey tool is based on a PHP frontend and a MySQL backend. There is almost no static text on the site at all. All strings and other variables are stored in MySQL tables, and the appropriate ones displayed as required. This allows the display of different strings for different languages, and multiple questionnaires can be displayed using the same mechanism - with different questions and section headers displayed according to the selection parameters from the MySQL database.

The software was further enhanced to make it possible to present a selected subset of questions for the different types of Respondents (Registry/Registrar/Regulator etc.), as well as for managing and monitoring the filing of completed questionnaires by Team Members and Administrators.

4.2.1 Interface Design

To the extent possible, the interface was kept clean and simple. There are two entry points to the site: https://dnsafrica.study (for the survey respondents) and https://dnsafrica.study/admin (for the consultants/administrators).

In both cases, a language selection option allowed the user to select the language of choice. The interface language defaults to the pre-defined language specified by the site visitor's browser, but can be overridden at any time. Selecting another language changes all relevant text – headings, prompts, questions and fixed answers[24]. When Arabic is selected, script reads from right to left, and is right justified instead of left justified.

Additional links lead to the authorisation letter from ICANN and other useful information for Respondents and Team Members.

[24] "Fixed answers" refers to dropdown lists of possible answers to questions, such as "Yes" and "No".

4.2.2 Question Development

An extensive process of question development took place, with multiple iterations and inputs by Team Members with specific expertise and experience in this area. Ensuring consistency with the question format and response was emphasised, and there was a requirement to limit free-form responses as far as possible, to facilitate comparison of responses. When question development was frozen on 2016-05-16, there were a total of 264 unique questions in the six questionnaires, or an average of 42 each. The ability to reuse questions was not initially envisaged, but as the number of questions grew, we implemented this both to reduce effort and to increase consistency. To this end, each question was given a unique ID, a sequence number (initially at intervals of 100, to allow the insertion of other questions), a language, a type, a category (this is a binary sum of all the questionnaires that the question appears in) and a maximum response size. The type and category have meanings as per the tables below.

Table 4-2: Questionnaire Types & Categories

Question Type	Type Meaning
S	Subject Heading
db	Drop-down list of countries
tl	Text long
dt	Date text
dd	Drop-down List
no	Number
tb	Text box
T	Title (main heading)
ss	Slider question (0-5)

Category Value	Category Meaning
1	Registry
2	Registrar
4	Registrant
8	Regulator
16	Reseller
32	IXP Manager
E.g. 1 + 2 + 4 = 7 = Registry + Registrar + Registrant	

In hindsight, the total number of questions could have been reduced to a more manageable number, as well as excising the common questions from each questionnaire and having them as a single, seventh questionnaire to be answered once by all respondents.

4.2.3 Language and Translation

Translation of the questions (initially written in English) into the three other languages was not without its challenges. As the subject matter was highly technical, with specific terminology, standard translation services were unlikely be effective. Instead team members were relied on for translation, with outside help enlisted in some cases. The translators had a relatively convenient method to execute the translation, whereby they could choose a question, and see all existing translations. By starting with automated translations and relying on team translators to check and correct these, the time required for translation was reduced significantly.

4.2.4 Questionnaire Statistics

There were six questionnaires, one each for:

- Registry;
- Registrar;
- Registrant;
- Regulator;
- Reseller; and
- IXP Manager.

Each questionnaire was available in four languages:

- English;
- French;
- Arabic; and
- Portuguese

Table 4-3: Questionnaire Statistics

Questionnaires	6
Languages	4
Total Question text strings	1056
Total Fixed Answer text strings[25]	1352
Incidental text translations for website	171

4.3 Data Gathering Strategy and Preparation

The data gathering strategy was based on four prongs: recruiting Respondents to complete the online surveys; obtaining suitable zone files for analysis; interviews with relevant role players in the industry; and desktop research. Knowledge of the DNS industry in Africa was used to map out a strategy for Team Members to follow in contacting individual respondents.

4.3.1 Training

Training sessions were made available for all Team Members and conducted weekly, for over 10 sessions. A slide presentation was made available to Team Members, and an online conferencing system provided by SudREN was used to go through the presentation, explaining the process and concepts. Participants were able to ask questions by text and speech, and recordings of the sessions were made available on the Admin website for Team Members.

[25] Predefined answer choices, typically in a drop-down list, such as "Yes", "No", etc.

4.4 Data Analysis Procedures

The database contains 264 unique questions (repeated in all four languages, and some also reused in multiple questionnaires, for a total of 1018), with 35,473 answers collected. The data was exported to MS Excel for further analysis. Despite a large team which not only signed up more than 1400 potential respondents (database users), but also made a concerted effort to persuade users to complete their questionnaires, 308 questionnaires were completed by 209 individuals in time for analysis (some individuals answered multiple questionnaires on behalf of the different groups). Thus, 15% of respondents provided a 22% response rate by questionnaires answered. This is a reasonable success rate under the circumstances.

Although at least two users per country were identified (except for Guinea-Bissau (GW)), with up to 296 for South Africa, for nearly half of the countries – 22 in total – there were no completed questionnaires at all. Note there were actually responses from 68 countries, including the UK, USA and various European and Asian countries. Similarly, despite repeated requests to the Registries identified, only seven were willing or able to provide their Zone Files - four countries and the three South African City gTLDs.

22 countries did not respond at all

To complement this questionnaire data, data from other sources was analysed to address some of the gaps. Wherever practical, the data is displayed in this report in graphical form, such as pie, bar and frequency charts, to ease understanding for the reader. Although the paucity of data made correlation and regression analysis difficult, these powerful techniques were used where appropriate, and often shown as X-Y Plots. Logarithmic scales were quite often needed due to the large range of values measured.

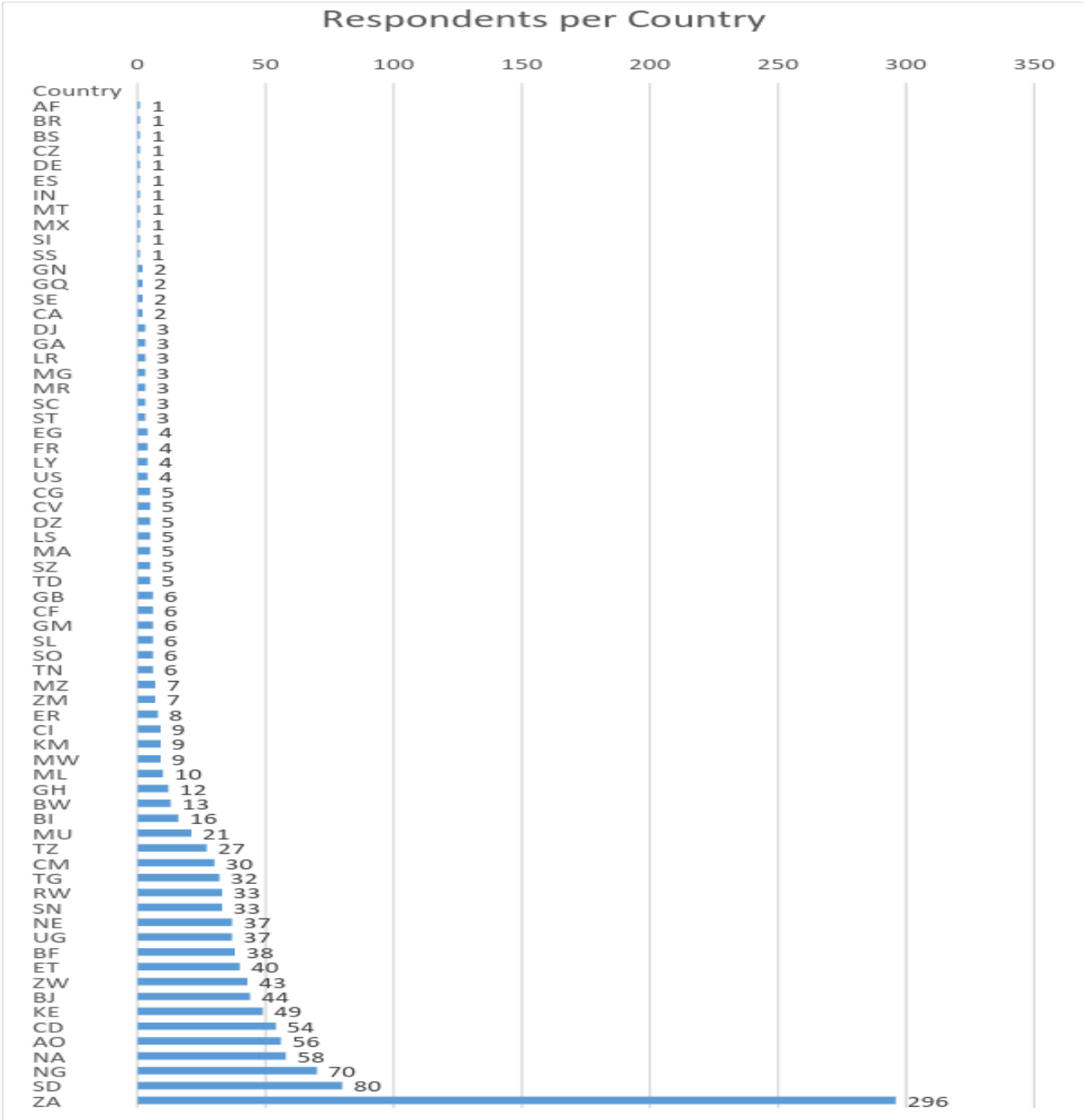
Table 4-4: Questionnaire Responses by Stakeholder Group

Stakeholder Group	Completed Responses
Registry	26
Registrar	34
Registrant	176
Regulator	16
Reseller	20
IXP Manager*	36
TOTAL	308

*This figure includes multiple responses for a single IXP. There were in fact 17 unique responses.

The graph below shows the number of respondents per country for those 32 countries with completed questionnaires.

Figure 4-3: Questionnaire Respondents by Country



5 THE AFRICAN DNS ECOSYSTEM

5.1 Africa Rising

This section provides an introduction to the broader African social, economic and Internet environment, and its impact on the Domain Name System on the continent.

Globally, Africa has the fastest growing digital consumer market. In terms of economic growth, the GDP of African countries is expected to grow at 5% annually between 2016 and 2025.[26]. In eight of the past ten years, Africa has grown faster than East Asia, including Japan. Africa will account for 80% of the projected 4 billion increase in the global population by 2100. According to the World Economic Forum, the accompanying increase in its working age population creates a window of opportunity, which if properly harnessed, can translate into higher growth and yield a demographic dividend[27]. In spite of this great optimism, the outlook still looks exceedingly challenging in much of the continent, with most Africans living on less than two dollars a day.

Since independence, African growth has been mainly driven by primary production and export, against a backdrop of high unemployment and worsening poverty. The economic crises which extended into the 1990s and then rebounded in 2008 exacerbated the declining terms of trade. Unemployment remains high, with official estimates of around 25% in South Africa and Nigeria.

Despite its many problems and much 'afro-pessimism', a number of factors have been identified by certain commentators[28] as causes for optimism:

- Africa now has a fast-growing middle class, around 60 million Africans have an income of USD $3,000 a year, as of 2011;
- The rate of foreign investment has soared about tenfold in the past decade;
- Cross-border commerce, long suppressed by political rivalry, is growing, as tariffs fall and barriers to trade are dismantled;
- Africa's enthusiasm for technology is boosting growth. It has more than 600 million mobile-phone users—more than America or Europe;
- The health of many millions of Africans has also improved;
- Skills are improving: productivity is growing by nearly 3% a year;

[26] https://www.weforum.org/agenda/2016/05/what-s-the-future-of-economic-growth-in-africa/
[27] https://www.weforum.org/agenda/2016/05/africa-s-economies-are-growing-fast-this-one-skill-will-ensure-that-continues/
[28] E.g. Economist (2011) 'The hopeful continent: Africa rising', The Economist, 3 December 2011, available online at http://www.economist.com/node/21541015

- A generation of better-educated young people of working age is entering the job market and birth rates are beginning to decline;
- Nationals working abroad are now the leading source of capital inflow;
- A property boom in cities such as Accra, Ghana, Dar es Salaam in Tanzania and other cities of the continent;
- Growth has also been stimulated by the travel industry;

In spite of the 'Africa Rising' inspirational narrative, challenging conditions continue to test the continent. Weak commodity prices and a tightening of the global financial markets have affected most countries in the sub-Saharan region. The 2016 Ibrahim Index of African Governance[29] (IIAG) which was commissioned by the Mo Ibrahim Foundation, projected cautious sentiments. The index indicates that the pace of progress across the continent is slowing down, especially on levels of security and economic opportunities.

However, the World Economic Forum identified three powerful positive trends that are likely to sustain Africa's growth. First, Africa has a young population with a growing labour force. Secondly, Africa is being rapidly urbanised with resulting economic expansion. Thirdly, African economies are accelerating implementation of technological change that enables their economies to leapfrog the limitations and cost of physical infrastructure in important aspects of economic life.[30] The 2013 Ernst & Young Report titled "Doing business in Africa from strategy to execution"[31], reported that, "the size, diversity and inherent complexity of doing business across the continent will continue to test even the best-laid corporate strategies for growth in Africa. Yet the rewards to be had are very real, and African governments and communities will continue to welcome responsible and committed investment". The report concludes by stating that fostering good, proper relations with all levels of government will continue to be vital to realising strategic aims.

5.2 The African Domain Name Space

There are 54 countries counted as part of "Africa" by ICANN, and served by the African RIR, AfriNIC. They are countries on the continent of Africa, as well as certain Indian and Atlantic Ocean islands. The ccTLD for one country, Southern Sudan (SS) has not yet been delegated.

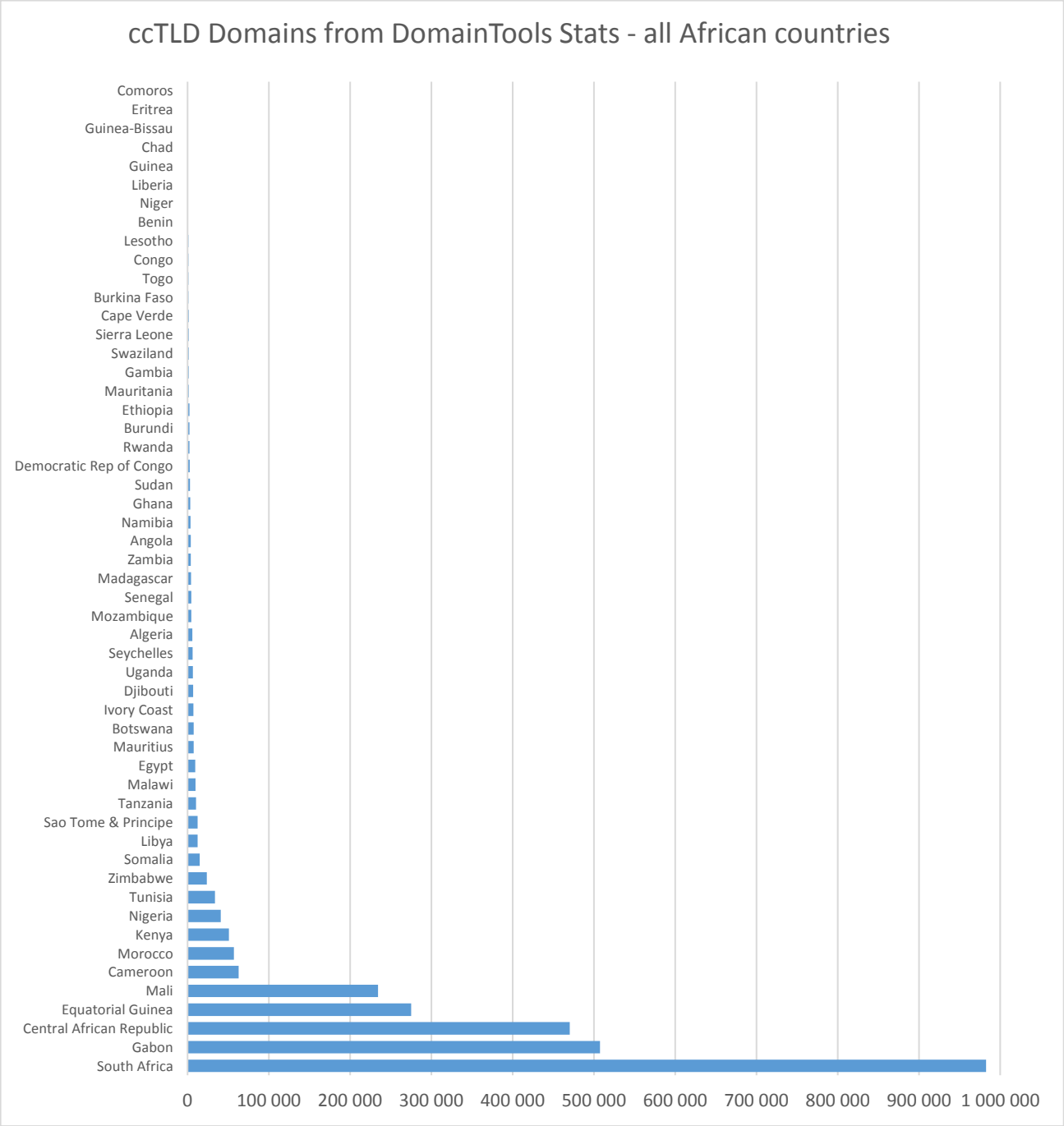
[29] http://mo.ibrahim.foundation/news/2016/progress-african-governance-last-decade-held-back-deterioration-safety-rule-law/
[30] https://www.weforum.org/agenda/2016/05/what-s-the-future-of-economic-growth-in-africa/
[31] http://www.ey.com/za/en/newsroom/news-releases/2013---press-release---march---african-markets-increasingly-open-for-business-but-positive-mindset-required

There are three new "dotCITY" gTLD domains: .CAPETOWN, .DURBAN and .JOBURG, with the .Africa gTLD delegated very recently.

In addition to traditional ccTLDs, a number of Arabic countries in Africa also have Internationalised Domain Name (IDN) ccTLDs, which are domain names that do not use the restricted subset of 63 ASCII characters as specified by RFC 883 of 1983 (since superseded).

The graph below shows the total number of domains registered under each African ccTLD. It will be noted that a number of countries have a disproportionately high number of domains registered. This is because domains under these ccTLDs are either provided "free" by registrars which derive advertising revenue from expired domains, (Mali (ML), Equatorial Guinea (GQ), the Central African Republic (CF) and Gabon (GA)) or are attractive outside the country for exploiting meanings inherent in the domain name (such as .LY for common English words). These are referred to as "domain hacks" and are discussed later in section 6.3.3.

Figure 5-1: ccTLD Domains for all Countries



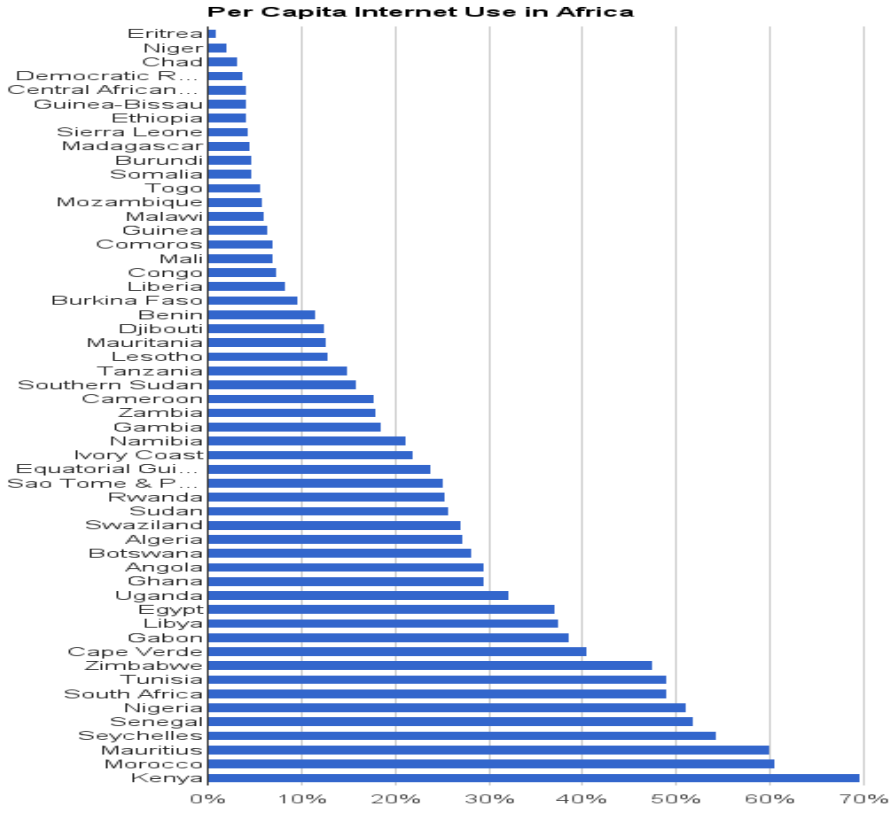
5.3 Internet Use

While there is a wide variation between the countries in Africa, as a whole the continent lags behind other regions in the use of the Internet and in the development of its local Internet industry. Another variation can be seen most notably in Sub-Saharan Africa (which contained

about 980 million people in 2015 versus 380 million in North Africa, which includes Sudan) which has a comparatively lower rate of development. Most Africans access the Internet using mobile phones. In 2015, the number of mobile broadband subscriptions per hundred people in Africa was estimated at just over 10%[32] compared to a world average of about 47%[33]. However this figure obscures wide variation between countries. As shown in the chart below, Internet uptake varies from almost 70% in countries such as Kenya and Morocco, to less than 5% in countries such as Ethiopia, the DRC, Chad, Niger and Eritrea.

Income is an important factor in determining Internet use, and further constraints are caused by the high cost of devices, limited relevant content and lack of digital literacy. However, the high cost of access and limited availability of infrastructure plays the major role in restricting Internet access, as discussed in the subsequent sections of the report, and as shown in the chart below, which underlines the wide variation in Internet uptake across the continent.

Figure 5-2: Per Capita Internet Usage



[32] http://www.gsma.com/newsroom/press-release/number-of-unique-mobile-subscribers-in-africa-surpasses-half-a-billion-finds-new-gsma-study/ Mobile broadband subscriptions overestimate the extent of real use of broadband due to the high cost of the metered traffic business model which limits extensive use. However it is the most up to date general indicator of Internet adoption. See https://www.apc.org/en/blog/inside-information-society-internet-governance-nee

[33] https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2015.pdf

The varying levels of Internet uptake shown above are not simply a matter of those who are either connected or unconnected. It is also a matter of the type of connection used. While there are those connected on high-bandwidth unlimited connections, the majority of people in Africa are connected on high-cost, low-speed metered mobile broadband links. Metered access and traffic caps severely constrain the amount of data that can be exchanged affordably, and restrict the user's ability to manage costs of access effectively - as costs cannot be predicted, thus creating a further chilling effect on use.

Access to cost-effective local Internet infrastructure has a direct impact on the potential growth of demand and supply for local content, and in turn, on the use of domain names and services. The variations in Internet uptake between and within African countries is largely a reflection of the state of development of the underlying Internet infrastructure, as outlined in more detail in the following section.

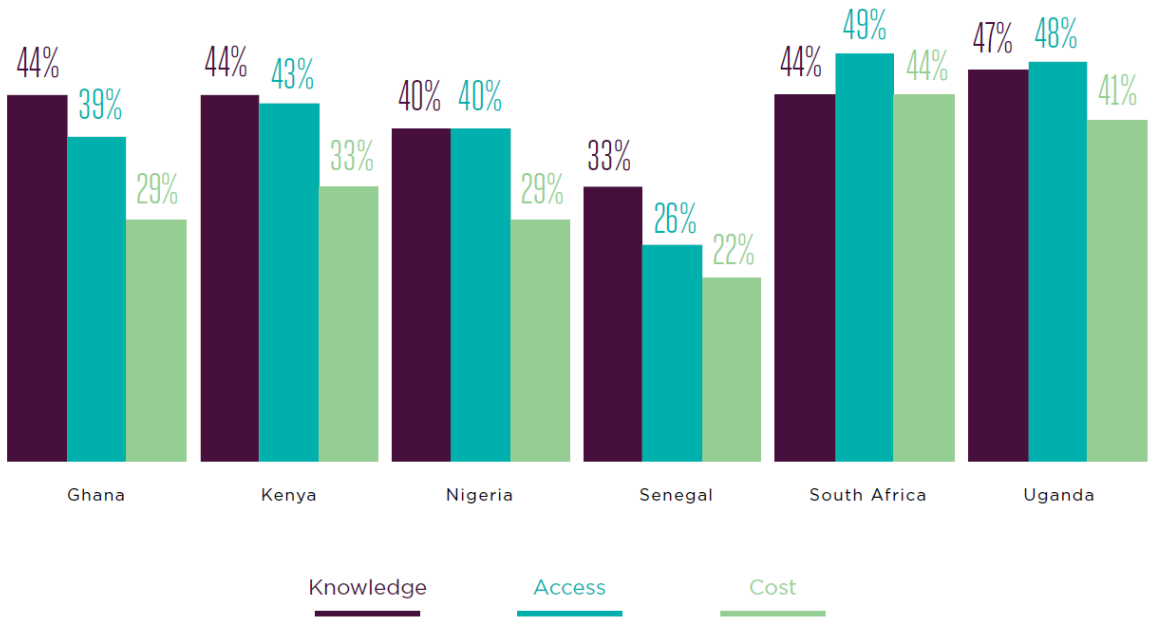
5.3.1 Digital Literacy

Basic illiteracy, digital illiteracy and lack of Internet awareness are among the consumer barriers to Internet adoption (2014 GSMA Digital Inclusion Report). Digital Literacy covers users' ability to use digital tools to communicate access, manage, integrate, synthesize and use information in order to achieve learning and other life goals. In Africa, the significant investments made into ICT infrastructure, content and services, and the increasing proliferation of smart devices need to be matched by investments into digital literacy if the continent is to maximize the opportunities presented by ICT.

Literacy has risen to prominence both as a human resource issue and as an equity issue — limited literacy has been identified as perhaps the most formidable barrier to crossing the so-called "digital divide," (Scardamalia, 2003). According to the 2014 GSMA Digital Inclusion Report, in 2011 there were 774 million illiterate adults globally, with developing countries accounting for the majority. The report notes that lack of English literacy prevents many native language speakers from using the mobile Internet. This highlights that literacy outcomes must include proficiency in basic language as well as technology. "A set of skills that allows a user to not only access the Internet, but to navigate websites, and evaluate and create information through digital devices" is required, added the report.

Figure 5.3 below outlines findings on the reasons why people in six African countries (Ghana, Kenya, Nigeria, Senegal, South Africa and Uganda) do not use the Internet. Knowledge, access and costs were cited as some of the reasons.

Figure 5-3: Why do people not use the Internet?[34]



The Digital Revolution is not transforming lives because citizens lack digital skills

The African Union (AU) has had to grapple with the reality that many of its member states' citizenry are not getting online. The digital revolution is not transforming the lives of citizens because they lack digital skill; they struggle to find an Internet that is relevant to them and critically: they cannot afford it. Many AU member states have had to generate National ICT plans in order to get more of their citizens online. An urgent call has also been made to the African Union to urge its Member States to make digital literacy a basic right for their citizens. The AU **e-Africa Programme** is mandated with the task of leading the African ICT agenda to ensure that it responds to the technological changes that are taking place. Capacity development and the promotion of digital literacy, e-Learning and ICT for education (through digital literacy training programmes), are part of the AU's Comprehensive ICT Strategy for Africa 2015 – 2025. Skills development remains key towards addressing the challenges facing the continent, hence the need to promote digital

[34] Google and Basis Research as cited in the 2014 GSMA Digital Inclusion Report

literacy training programmes and develop e-learning based local and localised content and services.

Figure 5.4 below maps out the AU's strategic goals and envisaged outputs.

Figure 5-4: AU Capacity Development Goals[35].

Strategic Goal/Theme	Strategy	Output
Capacity Development	Promote Digital Literacy, e-learnig and ICT for Education	ICT for Education and e-learning Policy Framework
		e-Learnining Capability and capacity
		Online Centres of Learning
		Digital Literacy Training Programmes
		Developed eLearning Based Content
	Promote development of specialist/expert capacity in Post & ICT	ICT and Postal Training needs identified
		ICT and Postal Training programmes developed and delivered
		Make a list of Training Institutions in the field of Post and ICT in the continent
	Promote and facilitate Knowledge Development and Management	Knowledge Collection and dissemination Platform
		Communities of practice and knowledge networking platforms
		Integrated Portals and Platforms across Regional and continental institutions
	Harness skills and expertise of African Diaspora in ICT development (cross-cutting across all strategic themes)	Database of ICT Experts in the Diaspora
		Increased participation of Diaspora in Programme Development and Implementation

5.3.2 Language Literacy and Impact of Local Content

One of the drivers of digital literacy is the availability of local content, defined as content and information that has a direct impact on the everyday lives of people and can specifically address key needs and challenges in the communities where individuals live and work[36]. Local content has a combination of local language, local relevance and is created locally. According to the 2014

[35] African Union Comprehensive ICT Strategy for Africa 2015 – 2025
[36] 2014 GSMA Digital Inclusion Report, page 53

GSMA Digital Inclusion report, the majority of 'local' content at present is international content simply translated, and a smaller volume of content is locally created and locally relevant.

Research informs us that across the globe, users are consuming more and more content through "apps" and the mobile Internet. Availability of local content plays a vital role in the adoption of the Internet in developing countries, but at present, the majority of content is in English and is largely focussed on data-heavy smartphone apps. Smartphone penetration is still low in the developing world and English is not the primary language, limiting the accessibility and usefulness of the content. To reach the widest audience, content needs to be available on as many devices as possible in languages the users understand, as well as being relevant to their local needs and interests. It is interesting to note that E-government services have emerged as a major source of local content for mobile Internet in developing countries, and as a driver for use of mobile Internet[37]. Creating content that is specific and relevant for developing countries is a difficult task, but is crucial as Local content raises awareness and drives uptake of the mobile Internet, attracting developers, increasing innovation, creating more value for stakeholders and increasing interest in generating more relevant content. This increases user engagement and pushes the uptake of mobile Internet further, creating a win-win situation for stakeholders across the entire ecosystem.

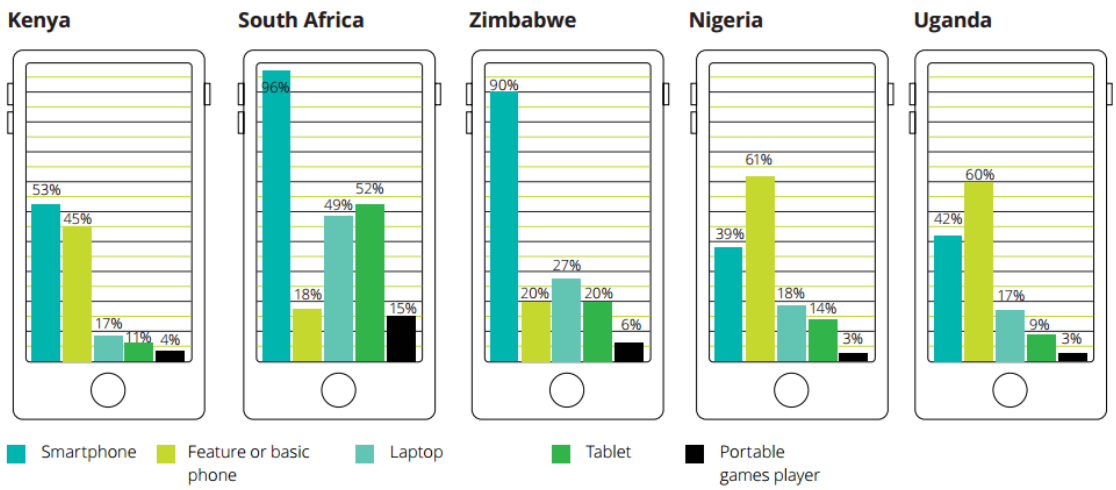
However, the bulk of Internet access using smartphones makes use of apps, which are typically tied to major websites such as Facebook, and therefore does not foster the sale of additional domain names.

5.3.3 Access to Smart Devices

Smart devices continue to drive Internet usage in Africa, as most Africans access the Internet using smart phones. Smart devices include smartphones, phablets, tablets, smartwatches, smart bands and smart key chains. The most widely used smart devices to access the Internet are smartphones and tablets.[38] The increasing affordability of smart devices is driving the increase in mobile broadband uptake in Sub-Saharan Africa, according to the 2016 Ericsson Sub-Saharan Africa Mobility report.

[37] *ibid*
[38] https://www.ericsson.com/assets/local/mobility-report/documents/2016/ericsson-mobility-report-november-2016-rssa.pdf , Ericsson Sub-Saharan Africa Mobility Report.

-Figure 5-5: Proportion of Respondents who Own Feature Phones versus Other Devices[39]



Both South Africa and Zimbabwe have high smartphone penetration compared to countries such as Kenya, Nigeria and Uganda, according to Pew Global Research.[40] The lowest levels of smartphone ownership are in poorer countries in sub-Saharan Africa, including smartphone ownership rates of two-in-ten or less in Senegal (19%), Burkina Faso (14%), Tanzania (11%) and Ethiopia (4%).

The availability of cheap smartphones over the next few years will enable segments of the population that are currently unconnected to incorporate Internet browsing into their daily experience, according to the Price Waterhouse Coopers (PwC) Entertainment and Media Outlook: 2015-2019 report[41]. In South Africa, some operators have launched basic entry-level smartphones.[42]

PwC also estimates that smartphone connections in South Africa will grow by around 160% from 24.8 million in 2015 to 64.6 million in 2020, a penetration rate of 60% that will continue to fuel mobile Internet access revenue growth, with mobile Internet penetration expected to exceed 70% by 2020[43]. Informa Telecoms & Media[44] projects that the number of smartphone connections in

[39] https://www2.deloitte.com/content/dam/Deloitte/za/Documents/technology-media-telecommunications/ZA_Deloitte-Mobile-consumer-survey-Africa-300816.pdf, Deloitte Mobile Consumer Survey Report
[40] http://www.pewglobal.org/2016/02/22/smartphone-ownership-rates-skyrocket-in-many-emerging-economies-but-digital-divide-remains/ , Pew Global Research Report
[41] https://www.pwc.co.za/en/assets/pdf/enm/entertainment-and-media-outlook-2016-2020.pdf , PwC South Africa, Nigeria and Kenya Entertainment and Media Outlook Report.
[42] Such as Vodacom's Alcatel One Touch Fire smartphone for USD $7 per month on post-paid or USD $120 on a prepaid, and MTN's Steppa 2 smartphones ranging from USD $60 to USD $75 on prepaid
[43] http://www.gsma.com/mobileeconomy/ GSMA Mobile Economy 2016
[44] https://iabsa.net/assets/PWCInternetReportSA.pdf

Kenya will exceed 12 million (26% of the population) by the end of 2017. In Kenya, more than half of total Internet advertising revenue already comes from mobile devices as smartphone owners grow in number, helped by lower data costs coupled with growing 3G and 4G access[45]

The most significant finding from another study was that Internet browsing via smartphones reached an average of 40 per cent in Africa, with 51% of respondents in Ghana, 47% in Nigeria, South Africa at 40%, Kenya (34%) and Uganda (29%)[46].

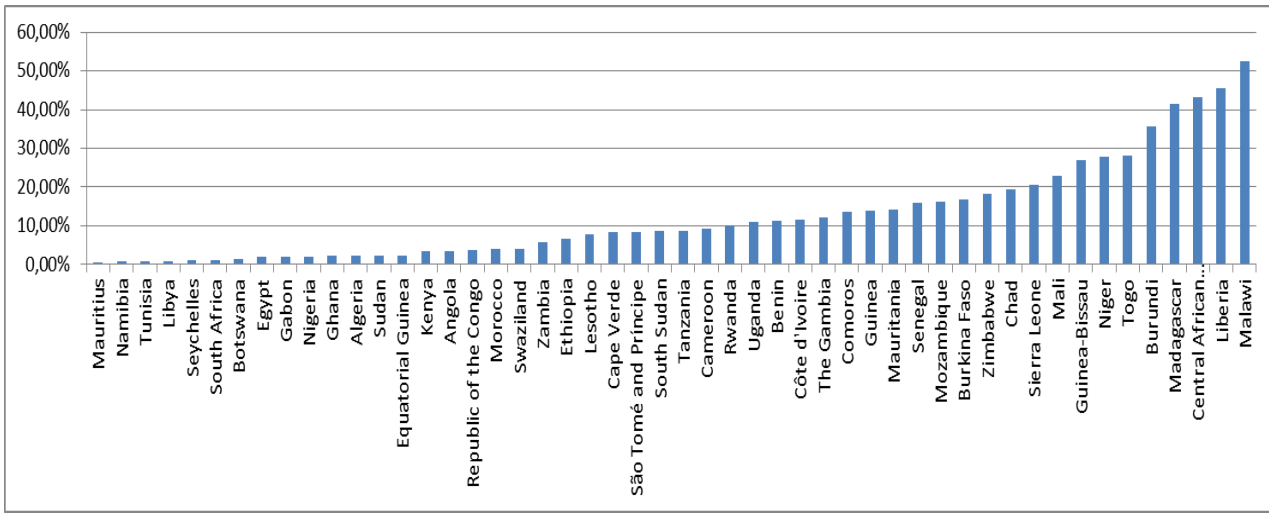
5.3.4 Cost to Communicate

Affordability of telecommunications services is a critical issue either enabling or hindering the uptake of online services. The affordability threshold of spending 5% or less of household income on access to telecommunications services[47] is widely considered a key barrier. Households or individuals required to spend above this threshold for a pre-defined basket of services are substantially inhibited in their ability to adopt and use services enabled on ICT platforms. Affordability is one of the issues tracked by the International Telecommunication Union in its annual Information Society reports.

Affordable access to mobile communications services is a key issue in relation to Internet access in Africa, where the access path is so predominantly via mobile telephones. In countries where mobile services are costly, Internet access and consequently DNS uptake is likely to be substantially inhibited. The graph below shows that there is a dramatic affordability divide across Africa for a pre-defined basket of mobile cellular services, with costs ranging from 0.6% of Gross National Income per capita (Mauritius) to a prohibitively expensive 53% (Malawi). The raw US dollar prices for the same pre-defined basket range from USD $1.13 (Seychelles) up to USD $23.87 (Cap Verde).

[45] https://www.pwc.co.za/en/assets/pdf/enm/entertainment-and-media-outlook-2016-2020.pdf , PwC South Africa, Nigeria and Kenya Entertainment and Media Outlook Report.
[46] http://www.worldwideworx.com/ , http://calleo.co.za/mobile-africa-2015-african-phone-use-decoded/
[47] http://www.broadbandcommission.org/Documents/Targets-Separated/Target-2.pdf

Figure 5-6: Cost of Mobile Cellular Services Basket as % of GNI[48]



When it comes to Internet access specifically, affordability is similarly a key issue affecting Internet access, uptake and usage. The ITU reports that African users can expect to pay on average 9.5% of gross national income for 500 MB of handset-based prepaid data, an order of magnitude more than the cost of the same amount of data in Europe (0.59%). The gap is similarly staggeringly large for 1 GB of post-paid computer-based data, which costs 21% of gross national income in Africa compared to 0.7% in Europe[49]. The range of prices across Africa also varies far more widely than in other regions, with the most expensive countries costing between 40 times and 107 times more than the cheapest.

Expensive Internet access and costly data translates into limited uptake of Internet and broadband services, which means limited demand for Domain Names and a sluggish DNS market.

Conservative spectrum assignments restrict the potential for new providers looking to make use of the latest technologies. For example, fixed broadband operators can use new wireless systems such as TV White Space (TVWS) and other dynamic spectrum-sharing approaches. However, so far only the Philippines has had the vision to make it a national priority to use these systems to help address connectivity issues. In many countries national regulators are not aware that most of the frequencies in TV wavebands are unoccupied, and the traditional occupants– the broadcasters – often do not understand the technology that makes it possible to share the

[48] ITU (2016) 'Measuring the Information Society Report 2016', International Telecommunication Union, Geneva, available online at http://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2016/MISR2016-w4.pdf, p 107.
[49] ITU (2016) 'Measuring the Information Society Report 2016', International Telecommunication Union, Geneva, available online at http://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2016/MISR2016-w4.pdf, p 135.

frequencies without interference[50]. In addition, incumbent operators use their high spectrum licence fees as a way of obtaining commitment from regulators to maintain their exclusivity over wireless markets.

Registries and Registrars across Africa would, therefore, be well advised to engage policy-makers and regulators with respect to the high cost of telecommunications services and the high prices of data. Moves in this direction have already taken place in a number of countries, where regulators - under pressure from the consumers of mobile voice telephony - have moved decisively to lower mobile termination rates (e.g. Botswana, Kenya, Mozambique, Namibia, South Africa, Tanzania, Uganda), and increase the affordability of mobile telephony for consumers[51]. Similar interventions with regard to data prices are still in their infancy[52].

5.4 Internet Infrastructure

As detailed in the following three sections, the state of Africa's Internet infrastructure can be viewed at three levels:

1. The backbone infrastructure which consists of:
    a. the international submarine and cross-border fibre backbones, which are usually operated by consortia of national and international carriers;
    b. the international satellite links, used especially in inland countries and rural areas, and;
    c. the copper, microwave and fibre national backbones operated by fixed and mobile retail broadband operators, and dedicated wholesale providers, some of which are government owned, others privately and some as private-public partnerships.
2. The local connection to the end user, usually provided by the national fixed and mobile operators, mainly using DSL, 3G/4G and Wi-Fi technologies, although there are also a significant number of satellite links and other fixed wireless services using licensed wireless spectrum. Fibre to the home (FTTH) is also beginning to be a factor in several African countries.

[50] https://www.globe.com.ph/press-room/first-ph-telco
[51] Stork, C & Gillwald, A (2014) 'Link between termination rates and retail prices in Namibia, Kenya and South Africa', *Telecommunications Policy* No 38
[52] Mann, D (2016) 'Data Prices Are Too Expensive For Most. You Should Care.', Huffington Post, 28 November 2016, available online at http://www.huffingtonpost.co.za/dillon-mann/data-prices-are-too-expensive-for-most-you-should-care/

3. The interconnection (IXP) and data centre/hosting facilities necessary to support interconnection between networks and to online services.

5.4.1 Backbone Infrastructure

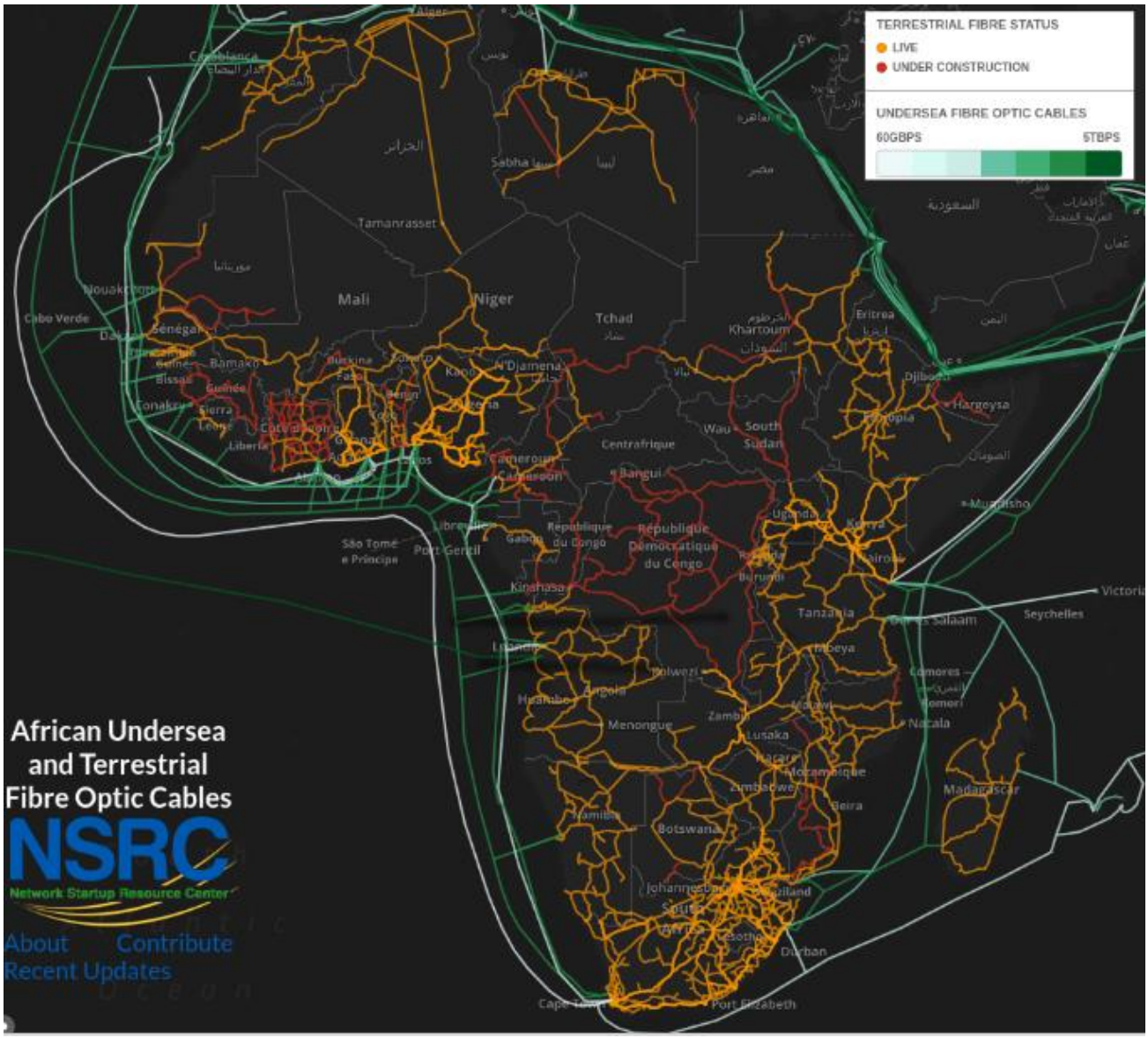
As shown in the map below, the penetration of backbone fibre infrastructure in Africa has increased rapidly over the last decade, especially in terms of the large number of submarine cables that now encircle the continent. All the coastal countries except Guinea Bissau and Eritrea have direct access to at least one submarine cable and most countries have access to at least two. This has greatly increased the availability of international capacity (to far greater levels than are currently used) and has driven down the price of international capacity to as little as US $20 / Mbps / month in countries where there are multiple competing cable landings. Only a decade ago, prices were as high as US $20,000 / Mbps / month[53] [54] [55]

International bandwidth demand has demonstrated enormous price elasticity, with the continent's inbound Internet bandwidth consumption increasing by 51% during 2015, and reaching 4.555 Tbps by December 2015. Africa has shown a CAGR[56] of 55.8% from 2010 - 2015, which implies that it should have exceeded 7 Tbps by December 2016.[57] During the last decade, the amount of Internet bandwidth consumed by Sub-Saharan Africa has increased by a factor of 230, from 12 Gbps in 2006 to 2,759 Gbps in 2015.

National fibre backbones are being extended or are being built in virtually all countries in Africa and now connect most secondary cities. Multiple cross border fibre links are, or will shortly be[58], present on all major routes[59], although it will still be some years before all the necessary interconnections are in place to provide seamless terrestrial connectivity across the continent. Further extensions of national backbones to more remote areas are still needed to ensure that the large rural populations present in Africa can be connected cost effectively.

[53] http://www.saide.org.za/resources/0000000390/Fair%20Access%20to%20Internet%20Report.pdf
[54] https://www.siemens.be/cmc/newsletters/index.aspx?id=13-451
[55] https://www.apc.org/en/press/east-africa-needs-fair-entry-ticket-afford-cybersp
[56] CAGR = Compound Annual Growth Rate
[57] http://www.africabandwidthmaps.com/?p=5186
[58] PIDA / ECOWAS infrastructure studies. Private communication
[59] As shown in the Afterfibre.nsrc.org map below

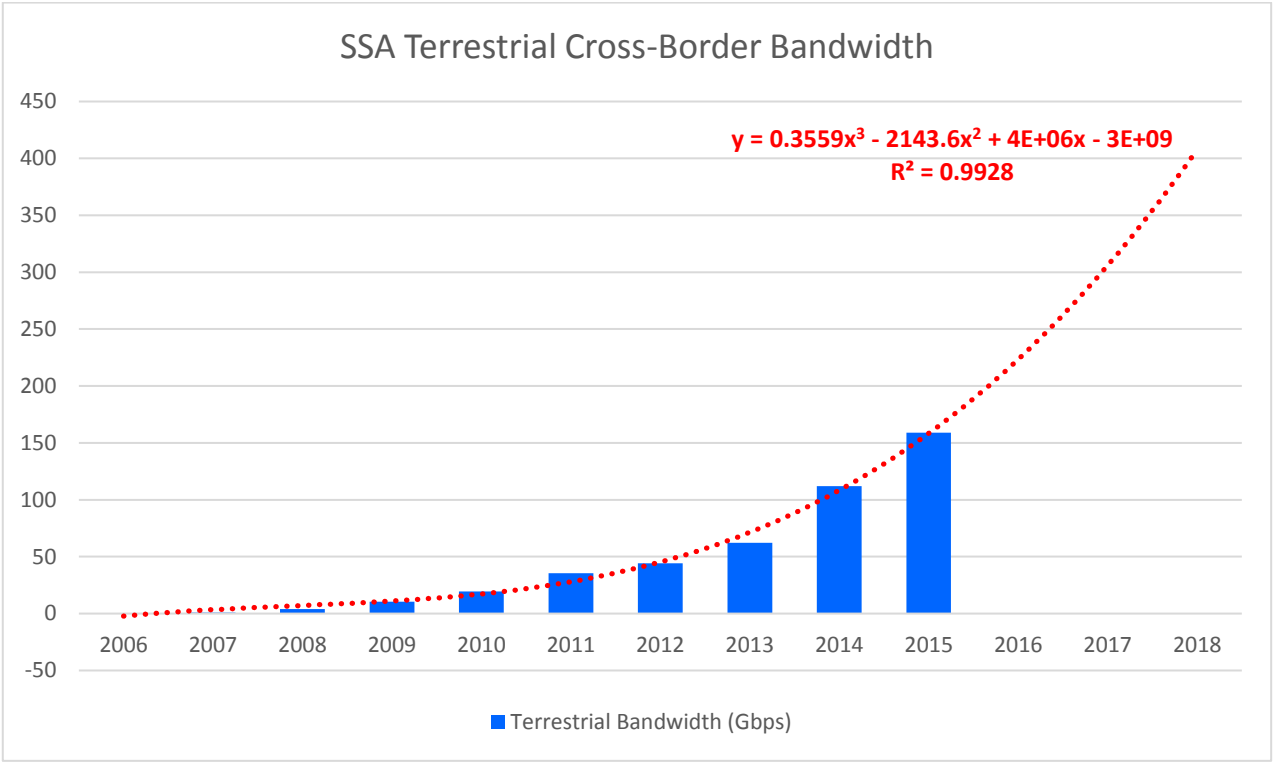
Figure 5-7: African Undersea & Terrestrial Fibre[60]



Of the total bandwidth of 2.759 Tbps in Sub-Saharan Africa by December 2015, 159 Gbps (5.7%) was supplied by terrestrial cross-border networks connected to submarine cables. The completion of new cross-border links, and the expansion of capacity on others, has seen the volume of intra-regional traffic backhauled to submarine cable landing points increase by 42% in the last year to reach 159 Gbps in December 2015.[61]

[60] Adapted from https://afterfibre.nsrc.org/
[61] http://www.africabandwidthmaps.com/?p=5186

Figure 5-8: Sub-Saharan Cross-Border Bandwidth



Despite the impressive growth in domestic backbone infrastructure, prices for domestic capacity still remain relatively high, usually much higher than the cost of international capacity. As a result it is cheaper, for example, to connect from Lagos to London than it is to connect from Lagos to Abuja. The relatively high cost of domestic capacity will continue to be one of the chief constraints to providing affordable high bandwidth services until more regional operators emerge and increased competition takes place, or wholesale price controls or similar measures are imposed on dominant operators by regulators. This also has special importance for the landlocked countries, which must pay for transit through their neighbours to gain access to the submarine cables. To remedy this, ECOWAS countries in West Africa are in the process of implementing an agreement to ensure that the land locked countries of Mali, Burkina Faso and Niger are able to obtain equal access to submarine capacity.

Prices for domestic capacity remain relatively high – often higher than international

Currently the market in many countries has been limited by African operators which have adopted a 'High Price, Low Volume' business model. Nevertheless, international and regional operators such as SEACOM, EASSy and Liquid Telecom are now disrupting the market with a 'High Volume, Low Cost' model which has reduced the cost of international traffic by several

orders of magnitude. Indeed, costs of submarine fibre capacity per Mbps per month have reduced from as much as USD $20,000 just over a decade ago to as little as USD $20 – less than 0.1%. As a result submarine cable operators are continuing to invest in this lucrative market of exploding bandwidth needs, despite the falling margins.

In terms of terrestrial backbone networks, the map above also highlights the extensive fibre networks present or under construction in most countries on the continent[62], although there is a lack of backbone and cross border infrastructure in central Africa in particular, as well as across the sparsely populated areas of the Sahel.

A number of emerging hubs are also apparent - in Accra, Cairo, Cape Town, Dar es Salaam, Djibouti, Lagos and Mombasa - where multiple international submarine cables interconnect with regionally linked terrestrial fibre backbones.

Because of the high cost of domestic capacity, traffic between different countries and regions in Africa largely transits over submarine cables. But over the next two years it is expected that cross-regional fibre infrastructure will be in place that can carry traffic terrestrially between most countries on the continent[63]. Combined with additional cables that are planned to link Africa directly with South America, and the potential to carry traffic to Europe via North Africa and the Mediterranean cables, the cost of transit is expected to drop sufficiently to encourage the establishment of more local and regional hosting and related DNS services (see Section 5.5.5 below).

5.4.2 Local Access Infrastructure - the Retail/Local Loop

It is currently estimated that only about 29% of the African populace has Internet access[64], primarily access via smartphones. With the limited deployment of copper cable, most Internet connections are provided by national mobile operators. The GSMA estimates that 2G mobile voice uptake reached 54% of the population by mid-2016, of which about a quarter were mobile broadband links, usually 3G, and sometimes 4G/LTE services in many of the major urban areas, with 2.5/2.75G GPRS/EDGE services in some of the more remote areas. It is estimated that 3/4G mobile subscriptions in Africa will rise to 573 million by 2019, up from 23% to 42%[65] of total mobile subscriptions.

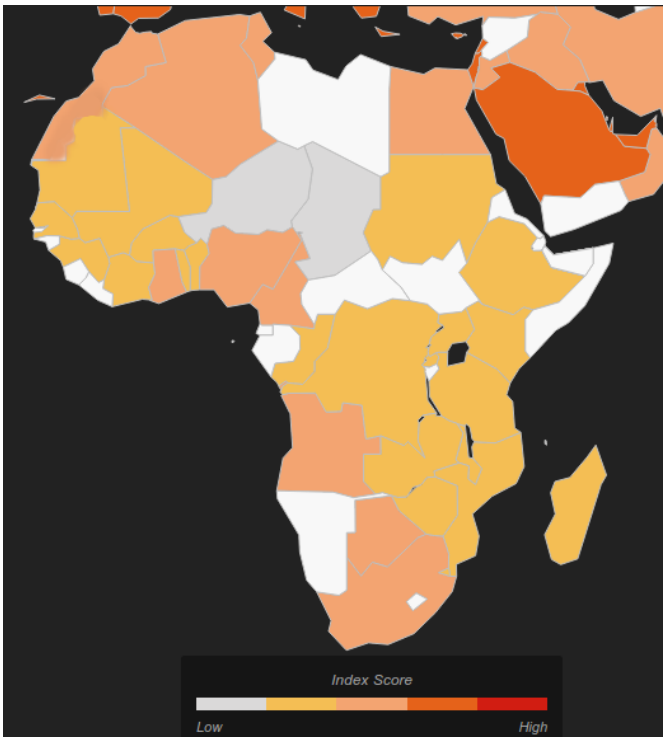
As shown in the map below of the GSMA Mobile Connectivity Index, only eight countries in Africa even reach median values - Morocco, Algeria and Egypt in the north, Ghana and Nigeria in the

[62] Egypt is 'dark' due to the lack of public information on fibre infrastructure in the country.
[63] Unpublished results of ongoing World Bank project, with which an author is involved

[64] http://www.internetworldstats.com/stats1.htm
[65] http://isoc-ny.org/afpif2015/AfPIF2015_Teleography.pdf

West, and Angola, Botswana and South Africa in the South. It is important to note that GSM / 3G / LTE last mile access makes use of licensed wireless spectrum. Suitable spectrum is in short supply in many countries, and is therefore referred to as "high demand spectrum".

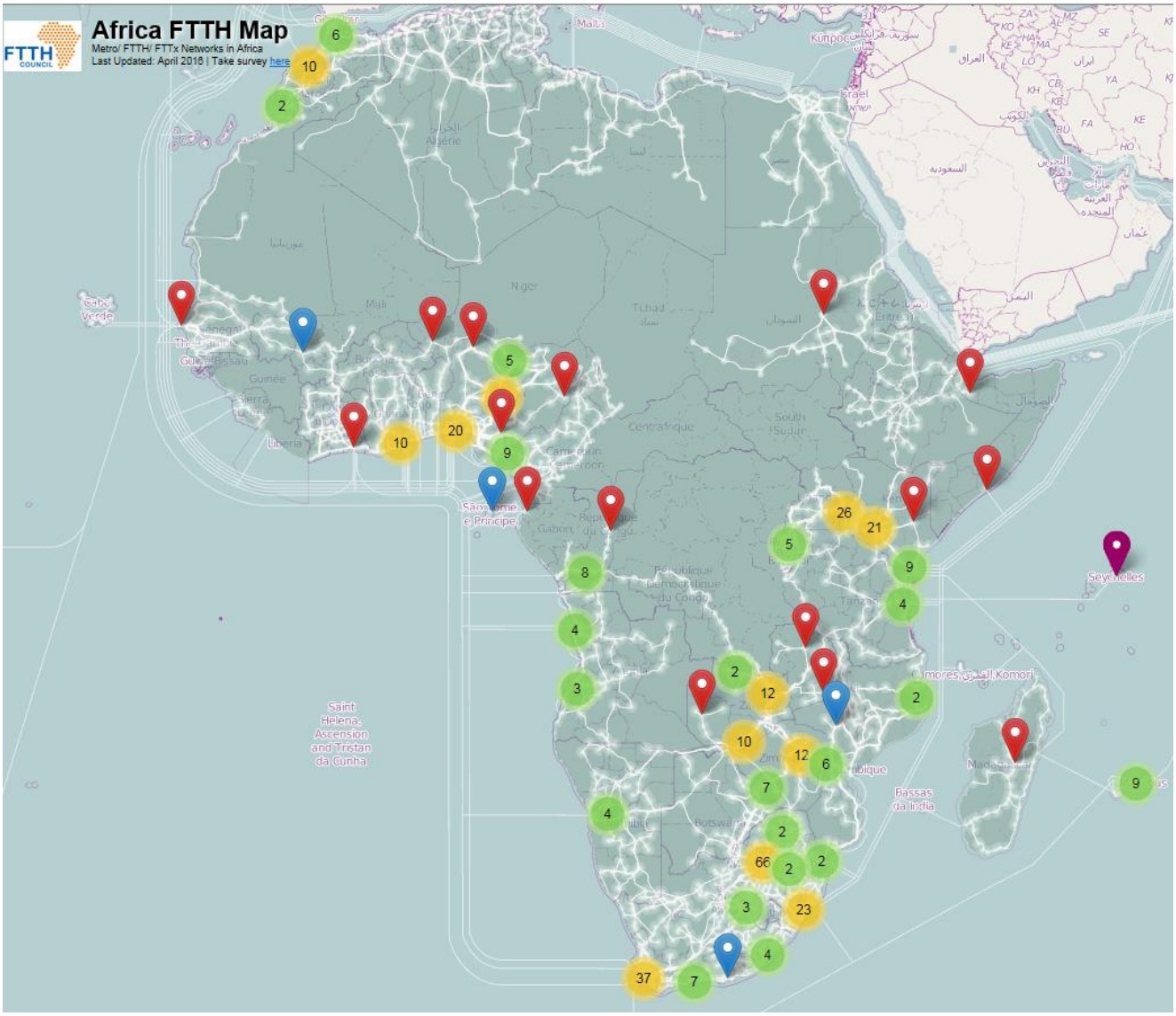
Figure 5-9: GSMA Mobile Connectivity Index[66]



A few countries have more extensive fixed line infrastructure, such as Senegal and South Africa, which provide a significant number of copper DSL-based fixed broadband links. Cable/Coax based connectivity is a rarity, except for the Seychelles, Mauritius, Mozambique and Angola. However, a growing number of metro fibre deployments has resulted in fibre to the premises being deployed in major urban areas in some countries. Aside from serving business and residential customers directly, metro fibre infrastructure is also a key component for encouraging more interconnection between major networks, development of local hosting facilities and cheaper access to international capacity. Outside of South Africa, major deployments of metro fibre have largely been seen in capital cities so far, particularly Accra, Dar es Salaam, Kigali, Harare, Kampala, Lomé, Lusaka and Nairobi. As a result these cities lead in provision of fibre to the premises (FTTx) as shown in the map below[67] [68].

[66] Adapted from http://www.mobileconnectivityindex.com/#globalRankings=overall
[67] Adapted from http://www.africabandwidthmaps.com/ftth/
[68] The blue pins in the FTTH map represent FTTH, the red pins, Metro fibre and the purple pins, FTTx. The coloured circles represent the indicated number of fibre networks at that location. The white lines represent fibre networks and the white highlights represent areas covered by a fibre node. FTTH = Fibre To The Home, and FTTx = Fibre To The (non-specific) premises

Figure 5-10: Fibre Networks in Africa



Other fixed wireless technologies are also in use, both in licensed and unlicensed bands, with free and pay-per-use Wi-Fi hotspots now relatively common in larger African cities. TV White Space (TVWS) trials using dynamic spectrum assignment technologies have successfully taken place in Ghana, Kenya, Malawi, Namibia, South Africa[69], Tanzania and Zimbabwe. Along with Wi-Fi, TVWS technology may be used for connecting rural areas, due to the superior propagation characteristics of the radio frequencies available in the largely unused VHF and UHF terrestrial TV bands. African Regulators are following the example of their colleagues around the world, such

[69] http://www.tenet.ac.za/tvws/recommendations-and-learnings-from-the-cape-town-tv-white-spaces-trial

as the USA, UK and Singapore, and are in the process of devising suitable licensing frameworks for TVWS technologies.[70] [71]

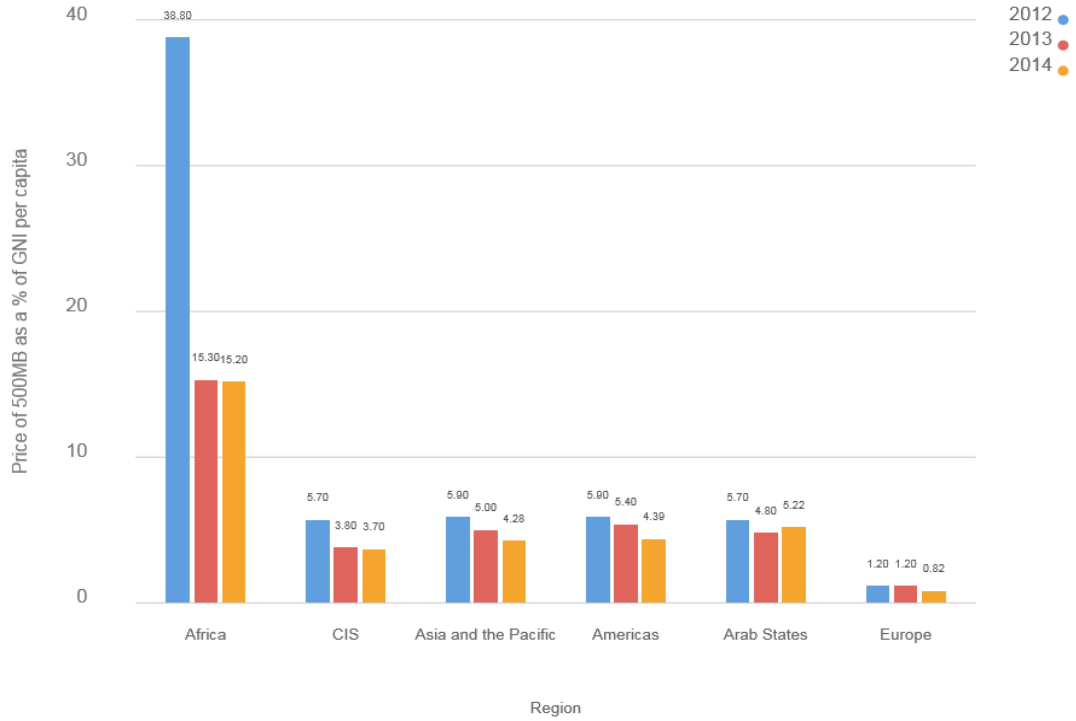
While broadband uptake in Africa has been increasing, high Internet access costs continue to be the biggest factor limiting usage in most countries, particularly for more isolated and disenfranchised groups. This also affects the many who may be 'connected' but are unable to make use of the full power of the Internet.

High usage costs, are compounded by slow speeds, with the mobile services used by most people usually having metered access and tariff caps that constrain the amount of data that can be exchanged affordably. In addition, complex tariff packages can limit competition and restrict the user's ability to manage costs effectively. The Alliance for Affordable Internet[72] (A4AI) estimates that for only 500 MB of monthly data — enough to watch just two minutes of video a day — the average African has to pay over 15% of his monthly income, compared with the average European, who pays less than 1%.

The average price of a 500 MB (prepaid, mobile) broadband plan as a % of GNI per capita, by Region[73] is shown in the chart below. This shows substantial improvement since 2012 in Africa, but highlights how much more expensive Internet access continues to be, compared to other regions.

Figure 5-11: Cost of Internet Access

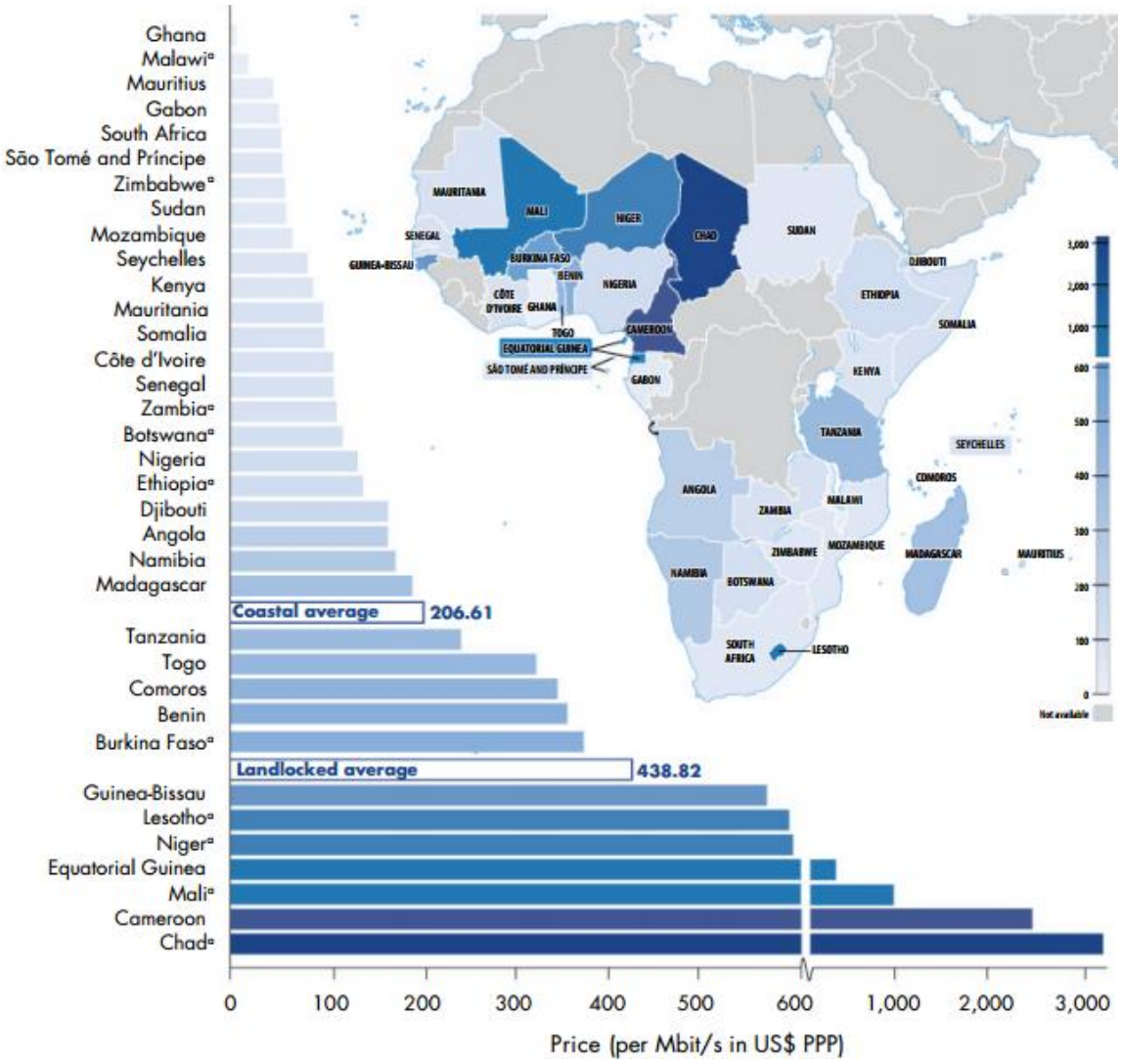
[70] http://www.gpwonline.co.za/Gazettes/Gazettes/39302_19-10_Icasa.pdf
[71] http://www.apec.org/~/media/Files/Groups/TEL/DSG/2015/15_tel51_dsg_wksp1_002.pdf
[72] http://a4ai.org/affordability-report/report/2015/
[73] http://a4ai.org/affordability-report/report/2015/#highest_adi_scores_among_least_developed_countries_(ldcs)



Fixed line broadband services are even more expensive in most countries, due to the high cost of terrestrial capacity. As a result the ITU estimates uptake of fixed broadband across Africa in 2016 at just 0.7%[74]. Landlocked countries exhibit the highest prices on the continent, as shown in the chart below from the World Bank's Digital Dividends 2016 report[75].

Figure 5-12: International Bandwidth 2015

[74] http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2016/ITU_Key_2005-2016_ICT_data.xls
[75] http://documents.worldbank.org/curated/en/896971468194972881/pdf/102725-PUB-Replacement-PUBLIC.pdf#page=238



High access cost has two important impacts on domain name demand:

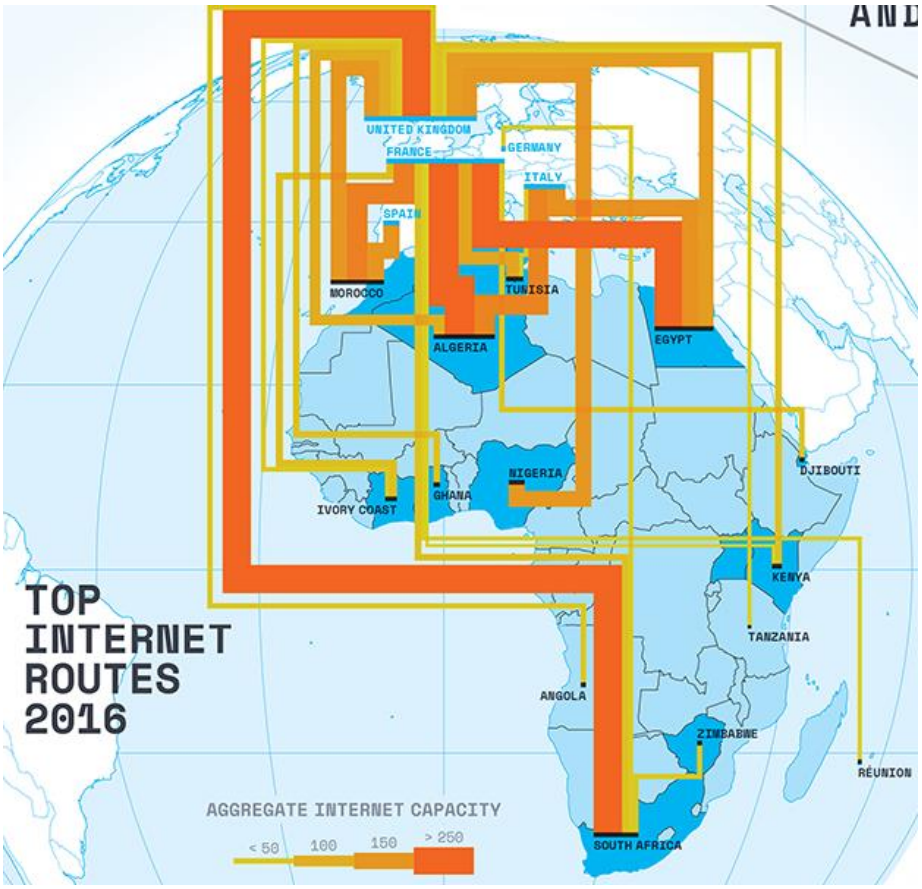
- it confines extensive use of the Internet to the very small proportion of the population that can afford it, and acts as a brake on in-country provision of Internet enabled goods and services;
- it may limit demand for domain names, because sites with less well-known domain names are less likely to be part of a Zero Rated service[76] such as Facebook or Wikipedia.

In addition, mobile network operators do not normally provide Registrar services, so for the majority of broadband users in Africa, marketing and fulfilment of domain name registrations is minimal, and would not take place via these access providers.

[76] At least one operator provides zero rated Internet access in each of 24 African countries: https://en.wikipedia.org/wiki/Zero-rating

Because most broadband providers only publish the number of subscribers, and do not make traffic data public, it is not possible to estimate the real extent of Internet use by the public. However international bandwidth consumption does provide a broad indication of aggregate levels of use, as shown in Telegeography's map below, which highlights the relatively high levels of use in Northern Africa and South Africa compared to other regions or countries.

Figure 5-13: Top Internet Routes[77]



Based on the Hamilton Research data for total international bandwidth used in Africa - estimated at about 7 Tbps by the end of 2016 - this works out at only about 5.6 Kbps per capita.

5.4.3 IXPs and Data Centres

The presence of data centres, IXPs and related hosting and caching infrastructure is a critical building block for supporting the development of online services and domain name servers, and in turn, demand for domain names. Without IXPs and related local services such as DNS, often referred to as "the building blocks of the Internet"[78] [79], much domestic traffic must flow over expensive and slower international links, including domain name lookups.

[77] https://africa-map-2017.telegeography.com
[78] https://www.ifex.org/kenya/2000/12/21/telecommunications_service_providers/
[79] http://www.broadbandforamerica.com/sites/default/themes/broadband/images/mail/AMKInternetPeeringandTransit_FINAL.pdf

5.4.3.1 IXPs

The potential cost saving was usually the primary reason for building and joining an IXP – exchanging local data locally, rather than over expensive international links[80]. This is no longer true, and in many African countries international traffic is significantly cheaper than local traffic. While this was indeed important, and in the early days of IXPs in Africa the potential volume of this data was grossly underestimated, other factors are equally compelling. The first of these is the enormous decrease in latency resulting from reducing intercontinental hops, down from up to ~200 milliseconds (fibre) or ~ 600 milliseconds (satellite), to a few milliseconds when data is exchanged in the same location. Even where North African countries have a relatively short submarine fibre hop length to IXPs in Europe, there are benefits in localising peering, which is why many countries have multiple IXPs (of which five countries are in Africa).

For the end user loading a web page with dozens of embedded web services and associated domain names, performance improves dramatically if the DNS lookups and the data are available locally (IXPs are usually the location for caching servers of content providers). This leads to a dramatic increase in network efficiency. The resultant increase in the quality of service makes local applications such as Internet banking, online ticket sales, online job markets and online tax returns feasible. The IXP may also offer a redundant path to international transit providers, thus increasing reliability. Finally, once the shortest path between two local ISPs is no longer via the UK, US, or other intercontinental route, it makes sense to host websites locally, with a significant multiplier effect in terms of data centres and the associated skills and economic activity.

Hosting websites locally in turn drives the demand for domain names, as well as driving the demand for data centres and for a range of related skills. Although many website owners still prefer overseas hosting (by which we mean outside the African continent), in countries where local infrastructure is more developed, it is clear that local web hosting is more common. For example, analysis of the zone files for this report shows that for .ZA 71% of the registered websites are locally hosted in South Africa, while a few .ZA sites are hosted in other African countries. For .SD 35% of websites are locally hosted and almost all others are overseas.

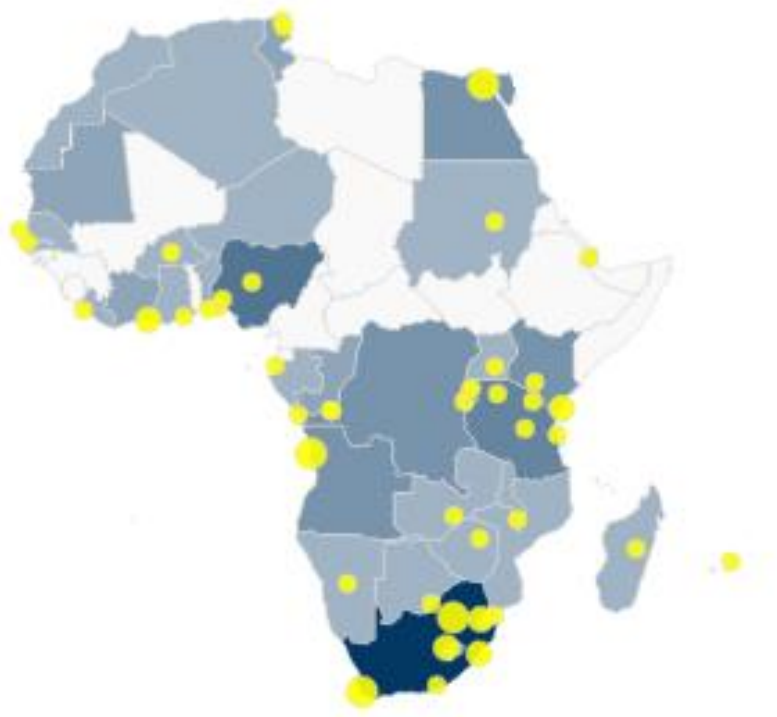
IXPs in Africa usually follow the European model of a non-profit facility established by its members (the network operators), usually in a neutral location where retail network operators and service providers can connect to each other to exchange data between their networks. Other kinds of interconnection and services occur at many African IXPs, such as commercial transit agreements and sharing of common services such as root name servers, local ccTLD DNS, CDN[81]

[80] The Halfway Proposition - http://hdl.handle.net/10568/57550
[81] Content Distribution Networks, such as Akamai, CloudFlare, RackSpace and others

servers and caching servers. There are also a number of bilateral peering links between networks in some countries, but these are private interconnections. In this respect an IXP would be expected to have at least three parties connected at a common point and actively exchanging data with each other.

Despite the fact that an IXP is neither technically hard to build, nor need it be expensive to set up, about a third of the countries in Africa still do not have them, and many that have been established are functioning sub-optimally. It turns out that IXPs are sensitive to a broad range of inhibiting factors that are often present in less mature African markets, such as a dominant fixed or mobile operator, high costs for leasing domestic links to the IXP, or lack of local hosting facilities, which are in turn affected by external factors such as the high costs and unreliability of energy supply. Thus the reasons for the low levels of IXP are related to the lack of enabling policy and regulatory environments that foster a vibrant Internet industry ecosystem[82],[83],[84].

Figure 5-14: IXP Locations[85]



[82] These conclusions come directly from the data gathered by the Survey carried out as part of this Study.
[83] https://www.internetsociety.org/sites/default/files/Promoting%20the%20use%20of%20IXPs.pdf
[84] https://www.isoc.org/educpillar/resources/docs/promote-ixp-guide.pdf
[85] Adapted from https://www.pch.net/ixp/dir

Nevertheless, over the last two decades the number of IXPs in Africa has increased significantly[86]. Although there are some 66 IXPs purportedly operating in Africa, after extensive research we have determined that many are either still in the planning stage, defunct, or are transit sales marketing campaigns, with no real traffic being exchanged. Where available, the IXP (and ISPA) websites and their reported statistics were examined, as well as the data from a number of IXP listings, as well as extensive research on the Internet for reports of traffic, peers, and operational status. On this basis, 30 IXPs have been excluded from the table below, which lists the 36 IXPs in Africa verified to be exchanging significant amounts of traffic, sorted by date established.[87]

Table 5-1: Operational IXPs in Africa

Country	City	IXP Name	Short Name	Peers	Traffic	Prefixes	Established
South Africa	Johannesburg	Johannesburg Internet Exchange	JINX	65	13.6 Gbps	176315	1996/06/01
Kenya	Nairobi	Kenya Internet Exchange Point	KIXP	30	1.33 Gbps	6276	2001/02/01
Zimbabwe	Harare	Zimbabwe Internet Exchange	ZINX	13	140 Mbps	270	2001/07/01
Egypt	Cairo	Cairo Internet Exchange	CAIX	7	1.39 Gbps	3447	2002/05/01
Mozambique	Maputo	Mozambique Internet Exchange	MOZIX	17	72.4 Mbps	1331	2002/07/01
Congo-DRC	Kinshasa	Kinshasa Internet Exchange	KINIX	9	618 Mbps		2002/11/01
Rwanda	Kigali	Rwanda Internet exchange	RINEX	14	1.36 Gbps	611	2003/01/01
Tanzania	Dar es Salaam	Tanzania Internet Exchange	TIX	36	4.59 Gbps	1858	2003/07/01
Uganda	Kampala	Uganda Internet Exchange	UIXP	8	1.55 Gbps	2692	2003/07/01
Botswana	Gaborone	Botswana Internet Exchange	BINX	14	1 Gbps	340	2005/10/01
Ghana	Accra	Ghana Internet Exchange	GIX	17	1 Gbps		2005/10/18
Mauritius	Ebene	Mauritius Internet Exchange	MIXP	10	30 Mbps	286	2005/12/01
Zambia	Lusaka	Zambia Internet Exchange Point	ZIXP	13	103 Mbps		2006/02/01
Angola	Luanda	Angola Internet Exchange	AO-IXP	12	600 Mbps	142	2006/03/17
Tanzania	Arusha	Arusha Internet Exchange Point	AIXP	6	100 Mbps	301	2006/06/26
Nigeria	Lagos	IXPN - Lagos	IXPN - Lagos	30	1.6 Gbps	2741	2007/05/01
Malawi	Blantyre	Malawi IXP	MIXP	36	10 Mbps	168	2008/12/01

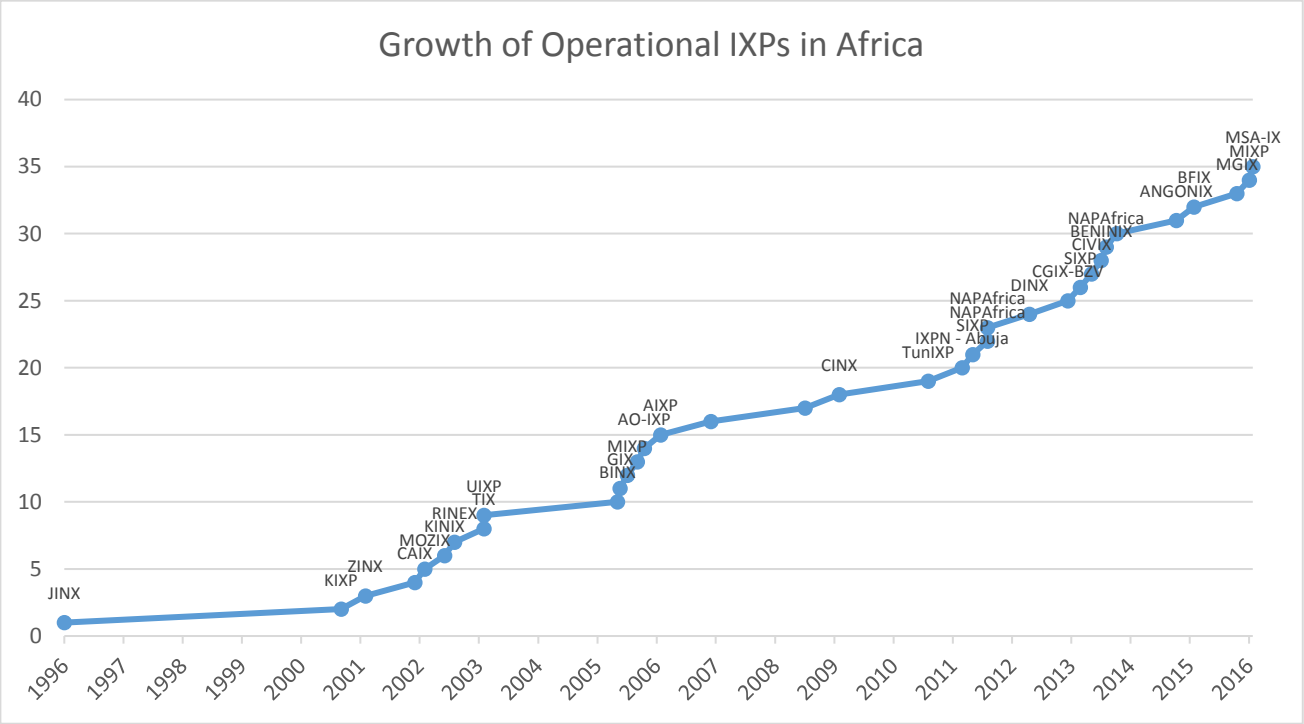
[86] Some of the authors of this study were directly involved in the formation of several of these new African IXPs
[87] Data from https://prefix.pch.net/applications/ixpdir , http://www.af-ix.net/ and https://en.wikipedia.org/wiki/List_of_Internet_exchange_points, and verification on individual IXP websites

Country	City	IXP Name	Short Name	Peers	Traffic	Prefixes	Established
South Africa	Cape Town	Cape Town Internet Exchange	CINX	180	3.6 Gbps	6462	2009/07/01
Tunisia	Tunis	Tunisian Internet Exchange Point	TunIXP	15		1150	2011/01/01
Nigeria	Abuja	IXPN - Abuja	IXPN - Abuja	4			2011/07/28
Sudan	Khartoum	Sudan Internet Exchange Point	SIXP	7	16.4 Mbps	683	2011/10/01
South Africa	Cape Town	NAPAfrica Cape Town	NAPAfrica	101	25.2 Gbps	9364	2012/01/01
South Africa	Johannesburg	NAPAfrica Johannesburg	NAPAfrica	234	160 Gbps	50 000	2012/04/01
South Africa	Durban	Durban Internet eXchange	DINX	6	16.2 Mbps	1430	2012/09/14
Congo - Brazzaville	Brazzaville	Congo Brazzaville IX	CGIX-BZV	7	4 Mbps		2013/05/10
Gambia	Serrekunda	Serrekunda Internet Exchange Point	SIXP	14	560 Mbps	113	2013/07/25
Côte D'Ivoire	Abidjan	Côte d'Ivoire Internet Exchange Point	CIVIX	6	79 Mbps		2013/10/03
Benin	Cotonou	Benin IX	BENINIX	6	952 Mbps	139	2013/12/01
South Africa	Durban	NAPAfrica Durban	NAPAfrica	41	6 Gbps	5807	2014/01/01
Namibia	Windhoek	Windhoek IXP		5	50 Mbps	109	2014/03/07
Angola	Luanda	ANGONIX	ANGONIX	16	3.2 Gbps	420	2015/03/09
Burkina Faso	Ouagadougou	Burkina Faso IXP	BFIX	9			2015/06/26
Madagascar	Antananarivo	Madagascar Global Internet Exchange	MGIX	6	16 Mbps	584	2016/03/16
Tanzania	Mwanza	Mwanza Internet Exchange Point	MIXP	3			2016/06/01
Kenya	Mombasa	Mombasa Internet Exchange Point	MSA-IX	3			2016/06/23
Djibouti	Djibouti City	DjIX	DjIX	0			???

Analysis of this data shows the growth of operational IXPs in Africa, displayed graphically below.

11 out of the Top 20 countries have had an IXP for more than 10 years

Figure 5-15: Growth of Operational IXPs



It is expected that the presence of one or more properly functioning IXPs, (by which we mean a number of peers exchanging meaningful amounts of traffic) would result in more domains being registered, and vice versa. Indeed, there is a clear relationship: Countries with an IXP that have sufficient peers exchanging meaningful amounts of traffic have, on average, six times as many domains as those without, as shown in the table below.

Table 5-2: Value of IXPs in terms of Domains

Country Status	Average number of ccTLD Domains per country
Countries without a properly functioning IXP	8 207
Countries with a properly functioning IXP	47 541

The only country without a fully functioning IXP that has more than 15,000 domains (other than those with "domain hacks" discussed in section 6.3.3) is Morocco with some 57,137 domains at the time of research. Packet Clearing House (PCH)[88] indicates that an IXP ("CAS-IX") exists[89] in Morocco, but has no information about it. A number of press reports claimed that it "will be

[88] https://www.pch.net/ixp/dir
[89] https://prefix.pch.net/applications/ixpdir/detail.php?id=1917

operational in March 2016", but none were found to confirm that it is actually functioning. Other causes must be sought to explain Morocco's domain name uptake. However, as noted above, Morocco is close enough to IXPs in Portugal and France for traffic exchanged there to largely compensate for the lack of a local IXP.

Countries with an IXP have 6 x as many domains

However, finding a simple numeric relationship between IXPs and domain name numbers was more challenging. In assessing the "value" of the 36 functioning IXPs, we looked at: -

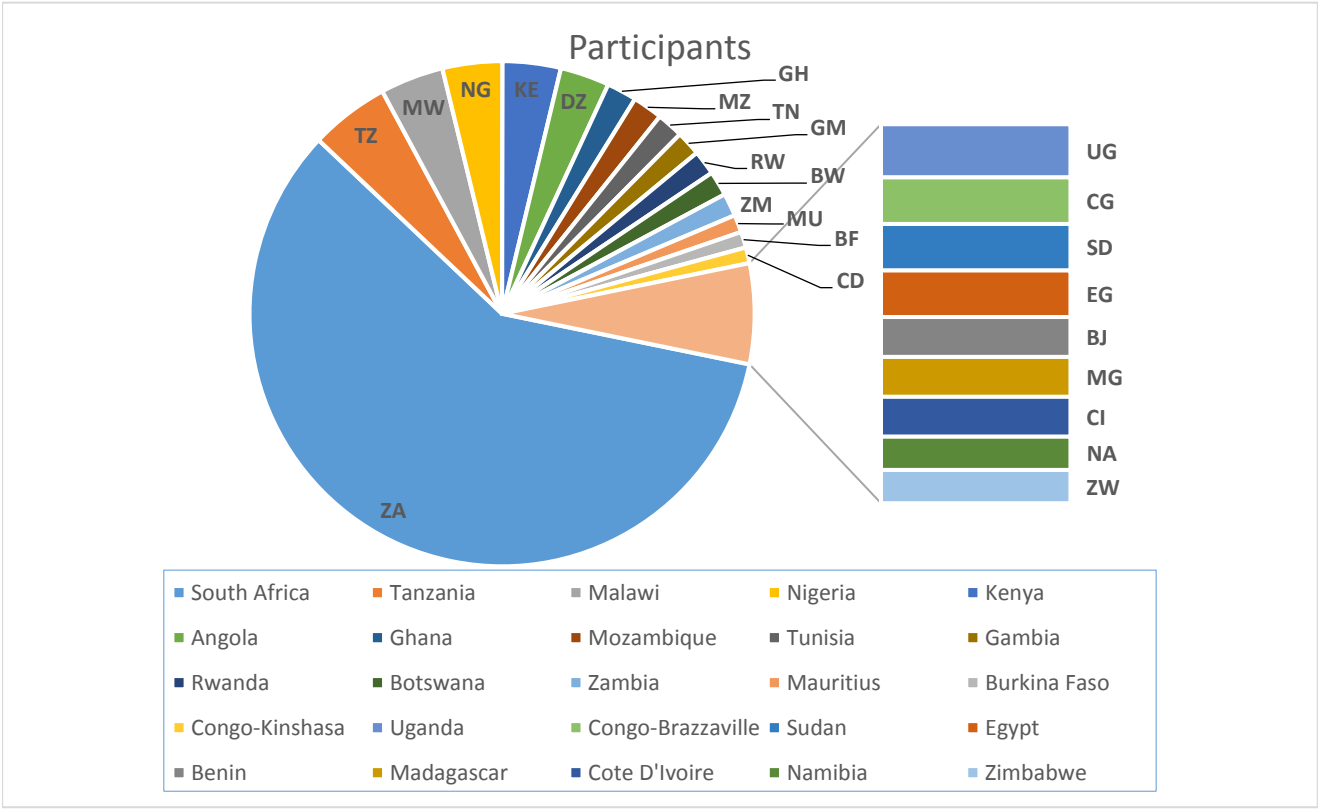
- Participants How many entities peering
- Traffic Peak traffic in Mbps[90]
- Age (days & years since establishment). A brand new IXP is unlikely to have an immediate impact
- IXPs The number of IXPs in a country. ZA, TZ, KE, NG and AO all have more than one functional IXP
- Prefixes A measure of how many / how large the networks connected to the IXP are

The following figures provide a graphical interpretation of these metrics. Firstly the pie and bar charts facilitate visualisation of the differences between results for African countries for the metrics listed above. In some cases, we exclude asymptomatic or outlier countries, indicated by "Excl." in the chart title. Secondly, in all cases where a correlation between two or more variables exists, an X-Y Plot and a calculated trend line was made (i.e. if the correlation is high, then the trend line is likely to be a good fit to the facts. If not, one should look for other causes).

We began by looking at the number of entities peering at African IXPs.

[90] Angola is a good example. **AO-IXP** was established in 2006. It has 23 participants exchanging 1,300 Mbps of traffic. This is quite significant. By contrast, **ANGONIX** was established in 2015, also in Luanda, but with 16 peers and 2,400 Mbps. Both IXPs are located at non-carrier-neutral locations, the former being hosted by the incumbent telco and the later by the submarine cable operator. Both hosts sell transit services. However, peers at the latter include the three mobile operators.

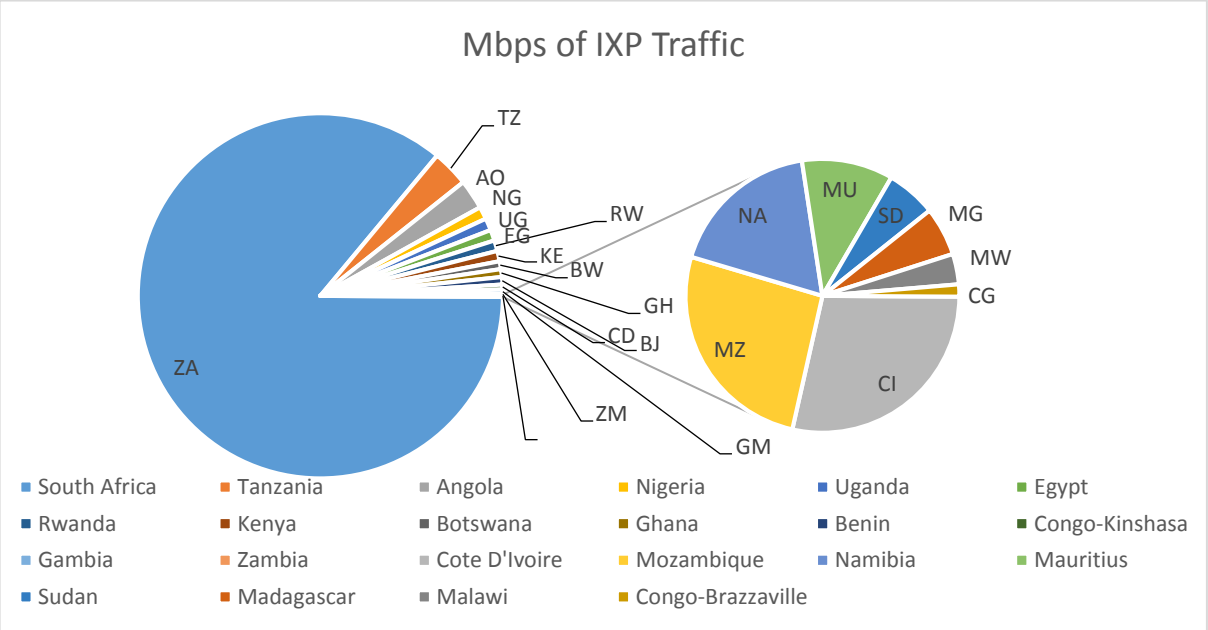
Figure 5-16: Participants at Operational IXPs



As can be seen, South Africa has more peers at its six exchanges than the rest of Africa put together, with Tanzania, Malawi, Nigeria, and Kenya following distantly behind. However, this can be misleading, as larger networks will connect to several IXPs. Indeed, of the 345 participants listed as peering at the three NAPAfrica IXPs in South Africa, there are only 233 unique participants, of which 68 also peer at the three INX-ZA IXPs.

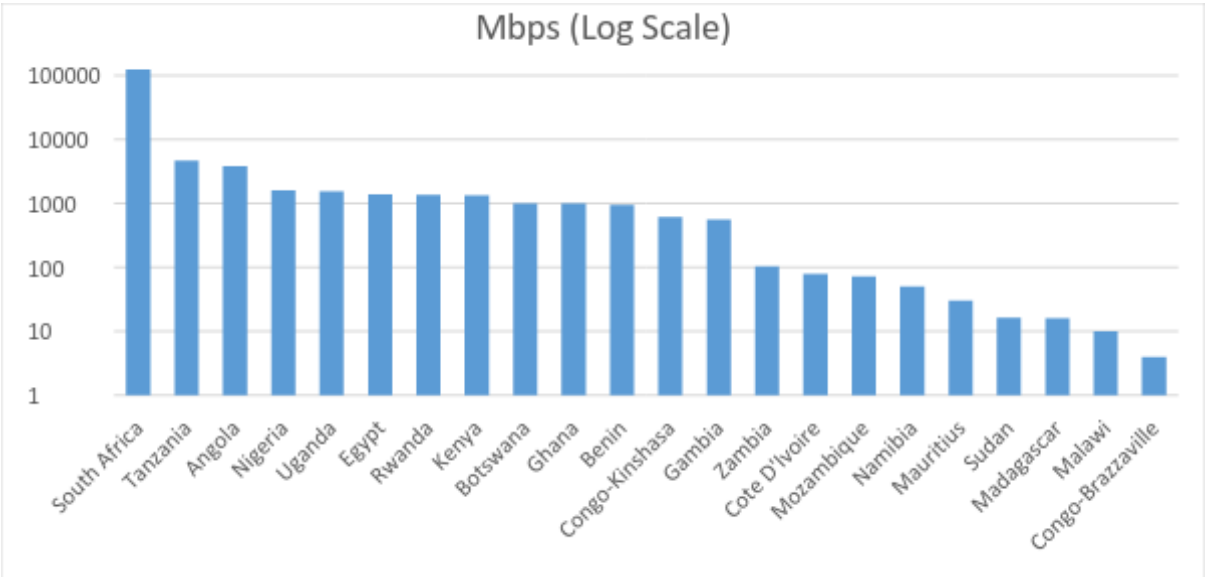
In terms of total traffic flowing over the exchanges, South Africa again dominates the continent, followed by Tanzania, Angola, Nigeria and Uganda, as seen in the chart below which shows peak traffic measured at the various African IXPs, compared to total traffic interchanged in Africa.

Figure 5-17: Total IXP Traffic



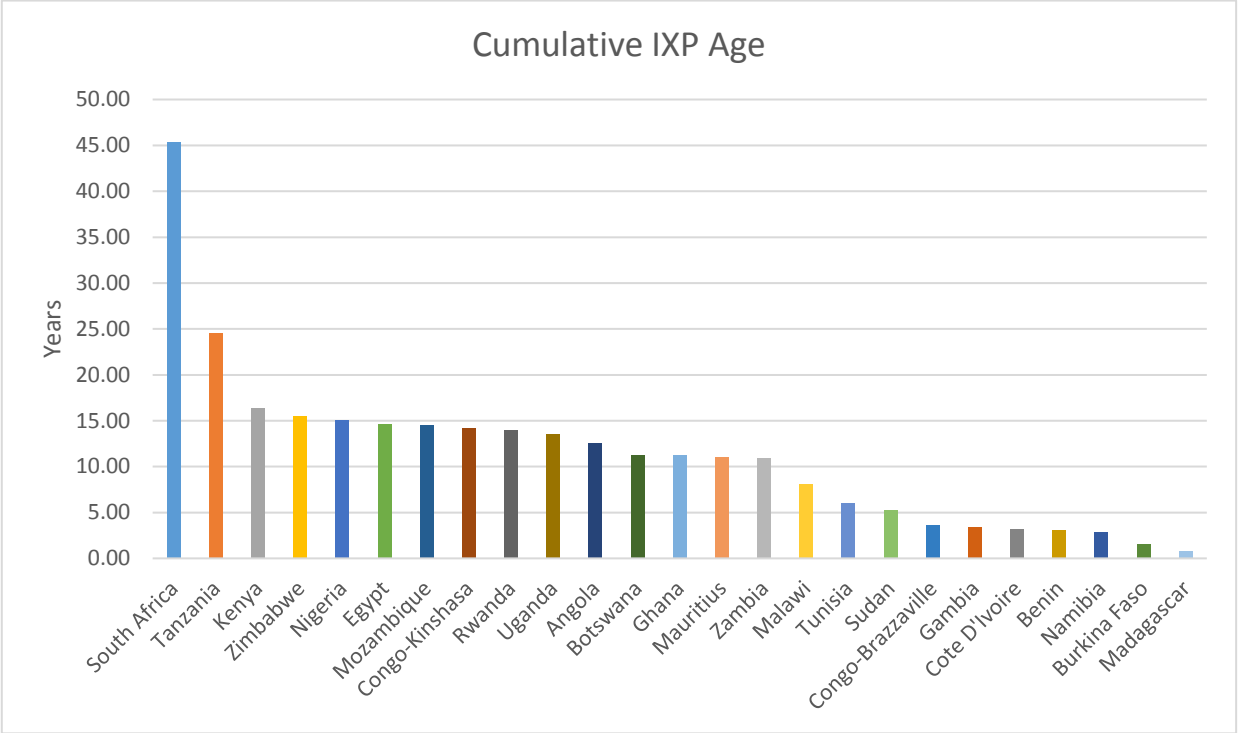
This same graph is shown below as a bar graph with a logarithmic scale, in order to highlight the numeric values indicated for the traffic levels.

Figure 5-18: Total IXP Traffic (Log Scale)



Where more than one IXP exists in a country, their ages are added together in the graphic below.

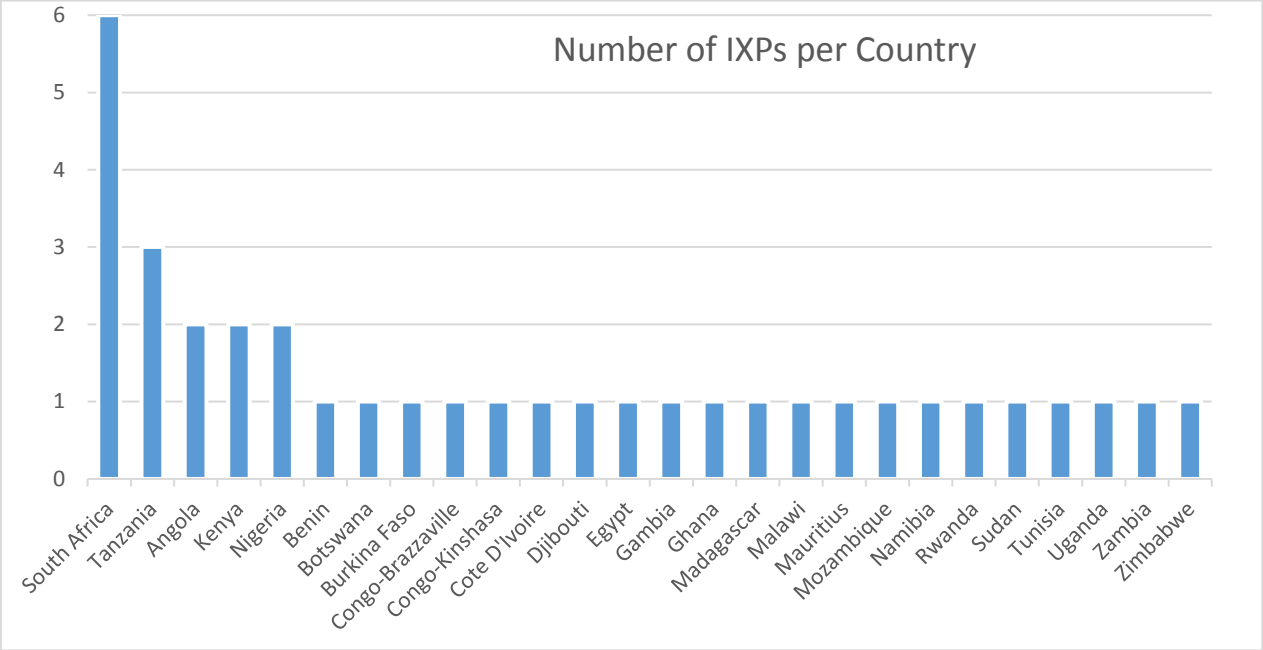
Figure 5-19: IXP Age



The longer an IXP has been operating within a country, the more effect one would expect it to have in terms of building up a local hosting and data centre industry, and hence contribute to the sale of domain names. This is shown in the column chart above. Once again, South Africa leads, followed by Tanzania, Kenya, Zimbabwe, Nigeria and Egypt. Although Kenya was the second country (2001) to have an operating IXP in Africa, its second IXP was only commissioned in 2016, so the other countries with multiple IXPs score more highly. It is noteworthy that of the 15 countries with more than 10 years cumulative IXP age shown above, all of them are in the Top 20 countries except for Mozambique (27th) and Angola (40th).

There is an argument that if one national IXP keeps national traffic local, several provincial IXPs will further localise traffic exchange. This is why several countries have multiple IXPs, namely South Africa, Tanzania, Angola, Kenya and Nigeria. This is shown in the graphic below.

Figure 5-20: Number of IXPs per Country

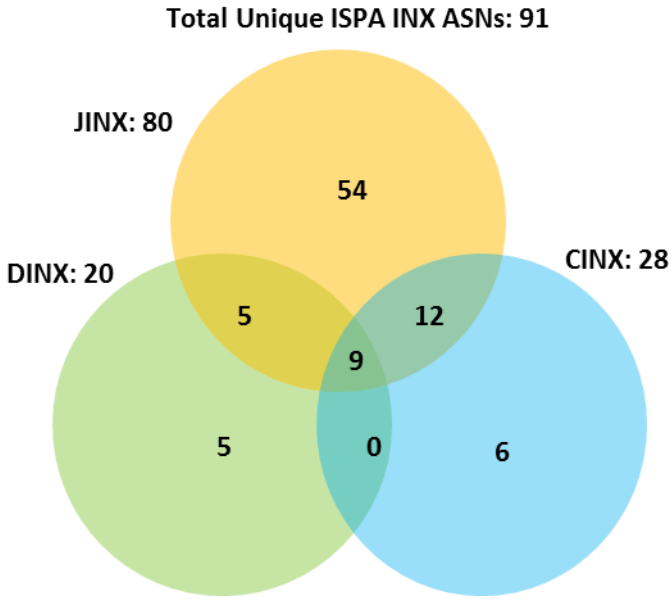


South Africa leads with six IXPs, followed by Tanzania with three IXPs and Angola, Kenya and Nigeria with two IXPs each. All other countries shown above have a single operating IXP so far. Although none of the individual parameters of an IXP have a good correlation with the number of domain names, as shown in the chart below, there is a clear – and logical - correlation between the total number of domain names registered in a country, and the total number of network prefixes routed over the IXPs in that country.

It's of interest to consider the situation where multiple IXPs exist in one country. Where do operators peer? In the case of South Africa, the six IXPs are in two sets, one operated by INX-ZA in each of Johannesburg, Cape Town and Durban, and the other operated by NAPAfrica, again in all three cities. In both cases, some operators peer at more than one city. Of the 345 peers listed at NAPAfrica, only 233 of them have unique ASNs. In other words, a number of these operators peer at more than one NAPAfrica IXP.

In the case of the INX-ZA IXPs, some of these are in fact at multiple locations, so JINX, for example, is currently available in three different data centres in Johannesburg (A distributed IXP). Once again, of the 128 listed peers, only 89 of them are unique, as some peer at more than one IXP. This is graphically illustrated by the Venn diagram below.

Figure 5-21: Intersection of Peering at IXPs

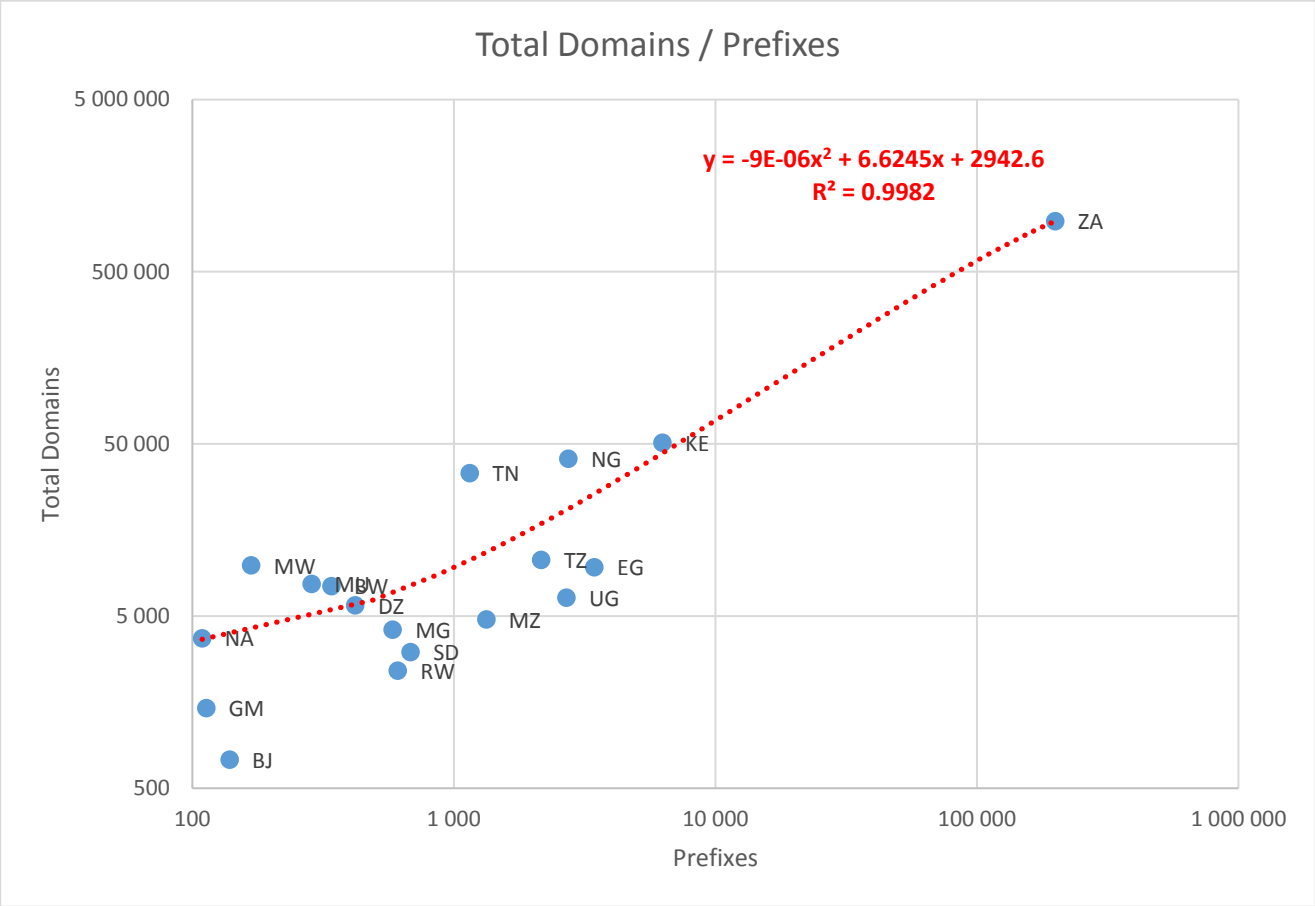


As can be seen, nine operators peer in all three INX-ZA locations, but no-one peers at both Cape Town and Durban who doesn't also peer in Johannesburg. In addition, 68 operators peer at at least one NAPAfrica IXP and one INX-ZA IXP.

The number of network prefixes and the number of domain names are effectively measurements of the size of the Internet ecosystem within the country. Domain names are labels for IP addresses, and prefixes are groups of IP addresses. As can be seen below, there is a significant correlation[91] between the number of domains issued by a country (a measure of the size of the DNS market) and the number of prefixes announced by the country at its IXPs (a measure of the size of the Internet in that country). This is not surprising as they are both measures of the size of the Internet in that country.

[91] The **coefficient of determination** (denoted by $\mathbf{R^2}$) is a key output of regression analysis. It is interpreted as the proportion of the variance in the dependent variable that is predictable from the independent variable. The closer to unity it is, the better the correlation.

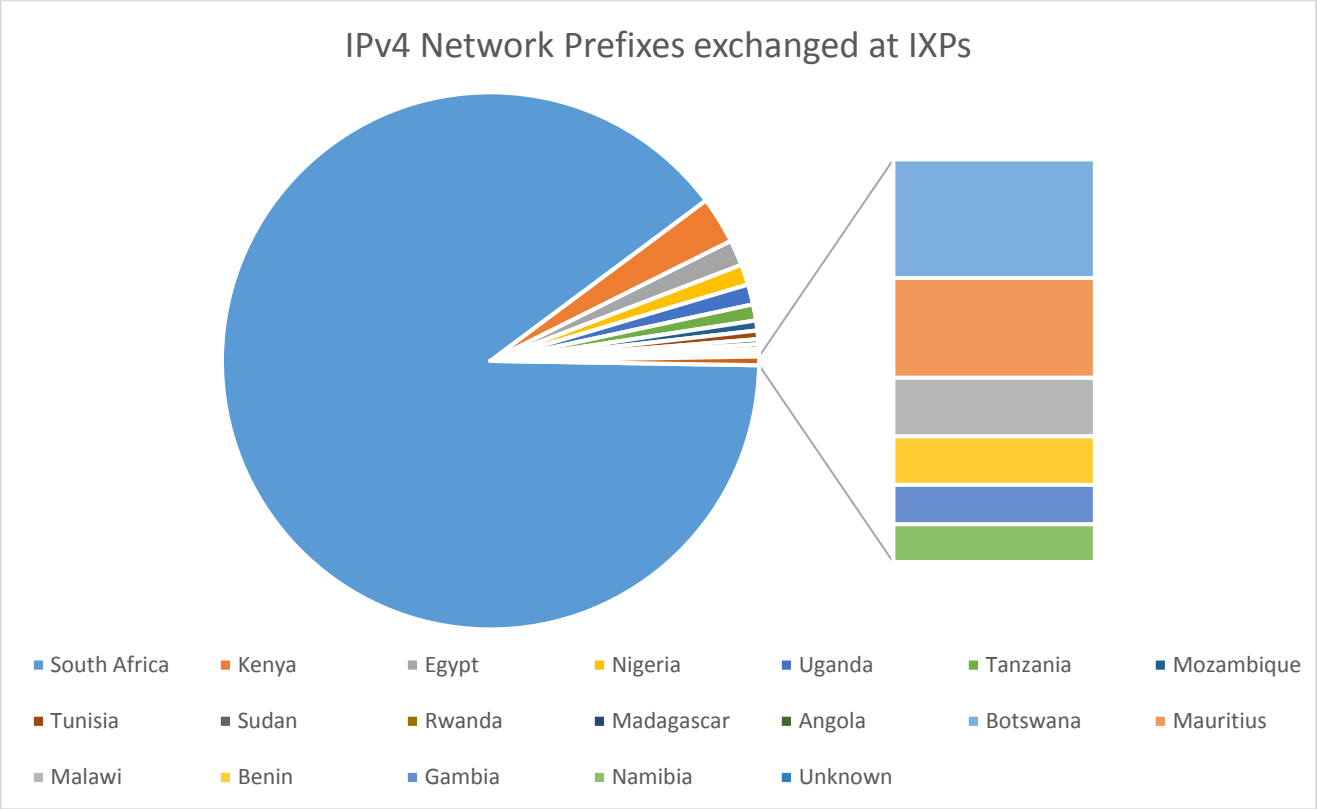
Figure 5-22: Domains versus Prefixes



As can be seen in the pie chart below, almost 90% of the IPv4 Network Prefixes[92] exchanged at IXPs in Africa are exchanged at the six South African IXPs.

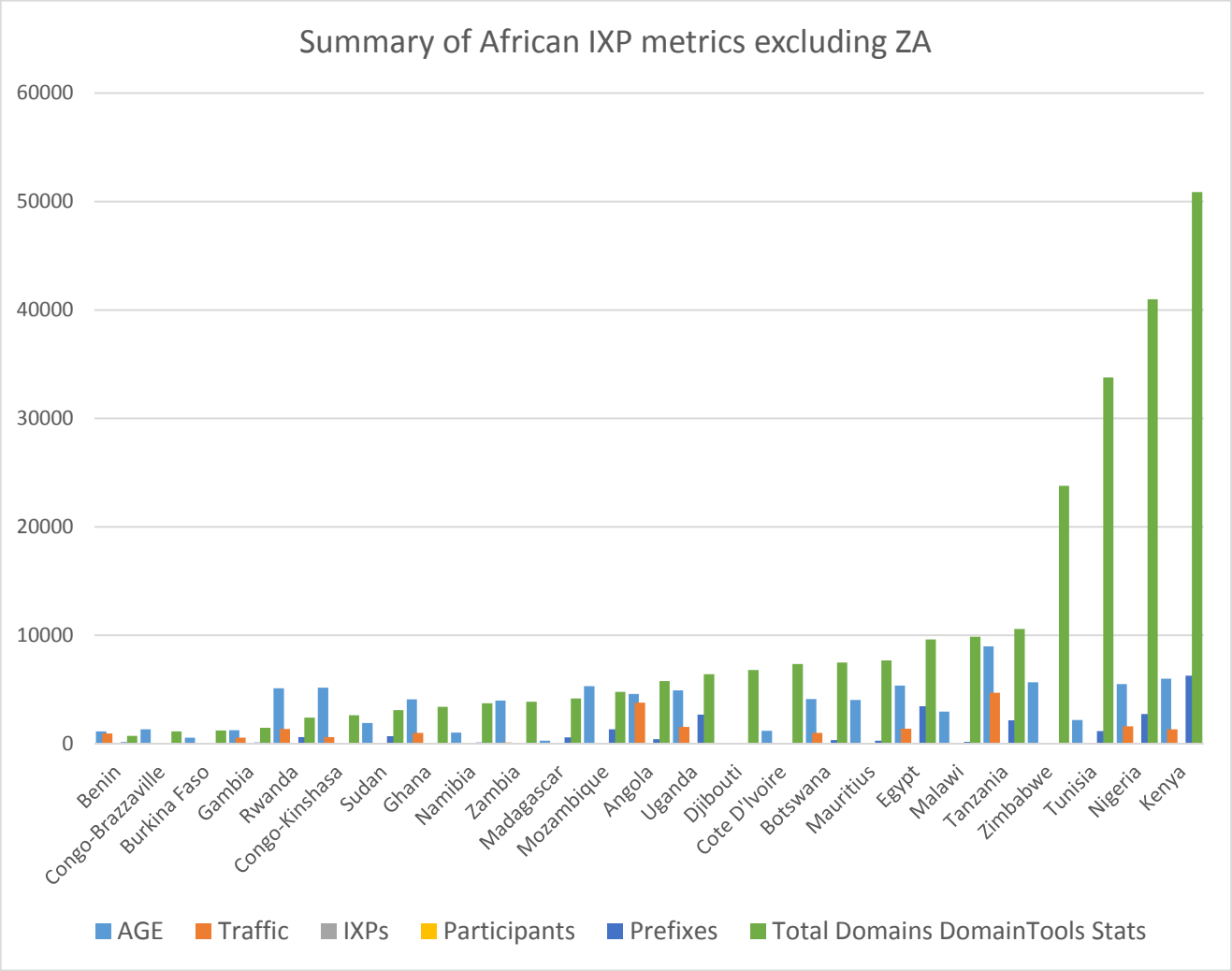
[92] A network prefix is the address of an IP network – so called because it consists of the first portion (of variable length) of the IP address. All addresses within the network start with the same prefix.

Figure 5-23: Prefixes at IXPs



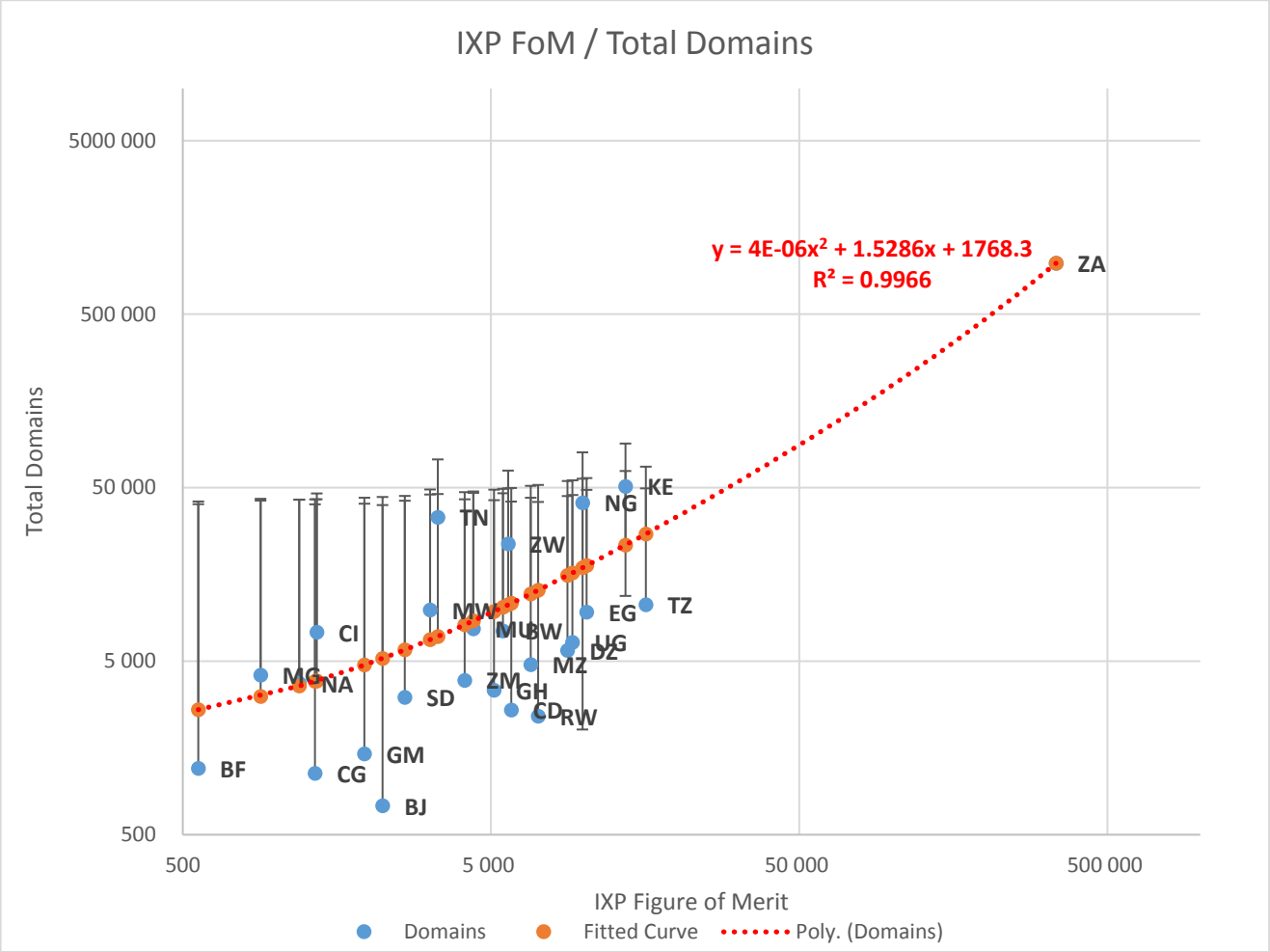
Although the numbers are clearly rising towards the right of the summary column chart below, this is irregular and none of these metrics on their own give a sufficiently good correlation with the number of domains registered in the ccTLD. South Africa is excluded from the infographic below, as the scale of most metrics is much higher and obscures the variation between other countries.

Figure 5-24: Summary Infographic for IXPs



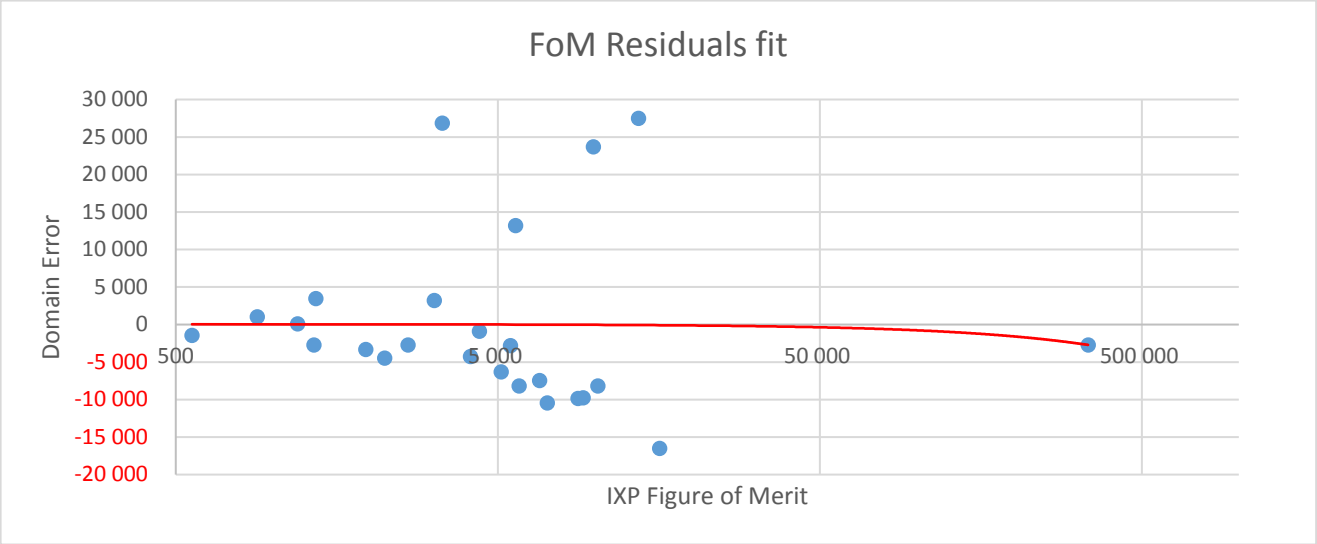
Combining these metrics (as a simple sum) gives us what we may call a "Figure of Merit" (**FoM**) for each IXP if we add all of these metrics together. Thus, we can now find a significant correlation between the metrics of an IXP and the country's domain names.

Figure 5-25: IXP Figure of Merit - FoM



With a value of more than 99%, this appears to be a very good correlation. This is confirmed by measuring how far the actual observed values are from the predicted. This is shown in the graph below, where we plot the differences between the predicted and the actual values (the "residuals"). Note that there are no particular areas where errors congregate and that the scale on the Y Axis at 30,000 is very small in comparison to the 500,000 above. This is further indicated by the trend line shown which is very nearly on the X-axis (indicating zero relationship between the X and Y axes), except near the isolated data point on the far right.

Figure 5-26: Confirmation of Good Fit for FoM



These two factors indicate that the relationship shown in red for the trend line on the IXP FoM / Total Domains graph is a good predictor, on average, for the number of domains, given a particular IXP Figure of Merit. Thus, the second order polynomial: -

$$y = 0.000004x^2 + 1.5286x + 1768.3$$

Where **y** = Total Domains and **x** = IXP Figure of Merit (FoM) is a good approximation to the relationship between these two variables: the IXP FoM and the number of domains.

19 out of the Top 20 countries have an IXP

However, as shown by the vertical error bars, there are still significant differences between the predicted number of domains and the actual value. This is to be expected, as this metric does not take into account a number of other issues that have a significant impact on domain sales, such registration method, payment method, cost of a domain, provision of a WHOIS[93] service and the registration policies applied.

Overall it can be observed that characteristics of the IXPs in a country are not a particularly accurate predictor of the number of ccTLD domains registered – at least not on their own. The reason for lack of any clear mathematical correlation is because there are other variables that are also influential on the number of domains registered. In addition there may be some inaccuracies in the traffic data (not all IXPs have recorded data available), and there is large

[93] A WHOIS service enables one to find out details about the people and machines involved in the registration of a domain name. Originally defined by RFC 812 in 1982, the current standard is RFC 3912. See https://tools.ietf.org/html/rfc3912

variability in the proportion of local networks that are actually participating at the IXPs - some large networks do not participate at all, or may exchange traffic bilaterally. As a result the actual volume of traffic being exchanged (locally or not), is not accurately indicated by the amount of traffic passing through the IXP. And, as noted above and discussed further below, there are a multitude of other factors that influence the number of domains sold in a country.

However, a comparison of the ranking of the top 20 countries shown in Table 7-2 with the ages of first IXPs in Table 5-1 shows a very clear link. Of the 20 top ranked countries, 14 are early adopters of IXPs and four are North African countries with nearby access to IXPs in Portugal, Spain and France. Of the remaining two countries, one has established an IXP recently. Thus, 19 out of the 20 top ranked countries in Africa operate a meaningful IXP, which has no doubt contributed to having a vibrant and expanding Internet industry.

5.4.3.2 Data Centres

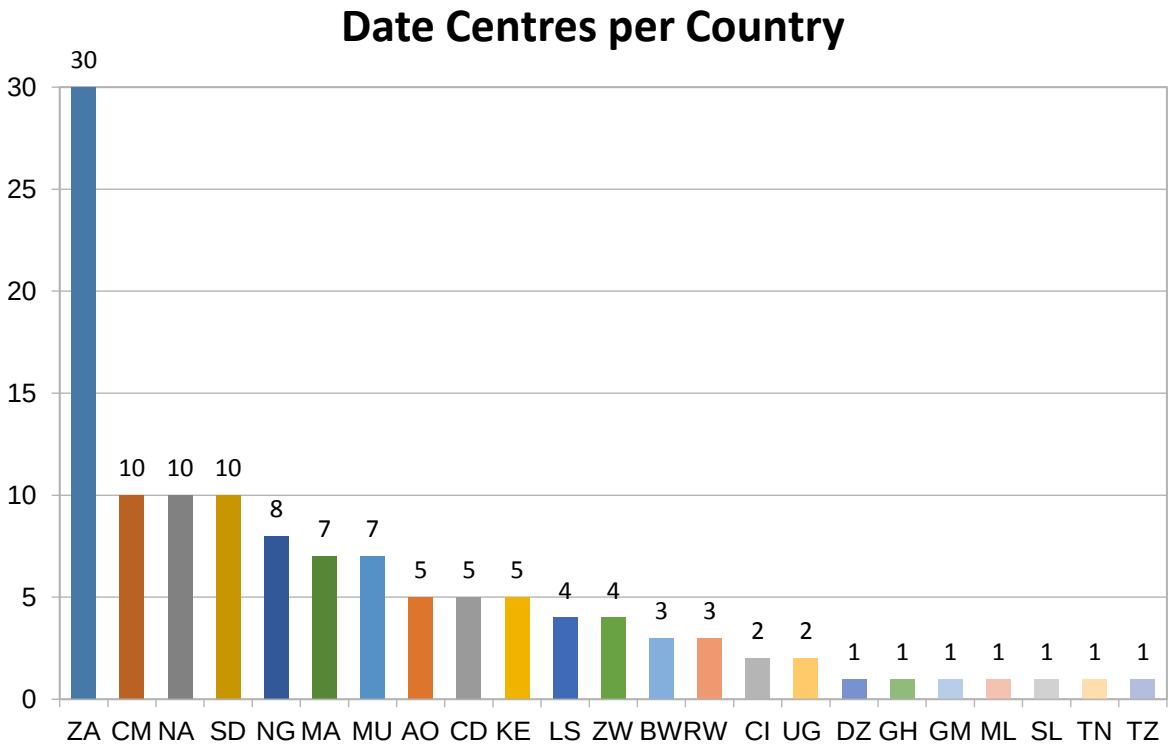
As indicated above, IXPs are often hosted at data centres, which may or may not be "carrier neutral". These also provide a convenient hosting environment for shared services such as DNS, CDN and caching facilities.

Registration of (especially local) domain names fosters the growth of the economy in terms of the construction of data centres to accommodate the machines hosting African websites, the IXPs to interchange local data, the telecommunications (especially fibre) infrastructure to interconnect these locations, and, of course, the need for skilled people to design, implement, manage and maintain these infrastructure elements.

In the Registry, Registrar, Reseller and IXP sections of the questionnaire, respondents were asked whether they used data centres for their service, how many data centres there were in the country and the approximate cost of a single cabinet in USD. The most common count for the number of data centres estimated by the questionnaire respondents was used for each country and is plotted below. Data from other sources on the Internet was also used to provide figures for a further seven countries from which there were no responses to the questionnaire.

This data produced an estimate of 127 data centres in 24 countries, as shown in the chart below.

Figure 5-27: Data Centres from Survey Data



Cabinet prices range from US $100 to US $2000 per month, although the bundled services provided with the cabinets were not noted in the questionnaire. In South Africa at Teraco for example a full cabinet plus 2 kW of power but no data connection, costs USD $700 a month. However, peering is free and a large number of transit providers are available to connect with the data centre.

Although there were a large number of unique responses (it was a free form answer), the reasons behind a lack of data centres were:

- Poor electrical supplies
- Monopoly telecommunication providers
- Lack of local need (content is housed overseas)
- Distrust of government
- High prices

The reports quoted below, and our own questionnaire responses, give differing answers for the number of data centres, largely because there is not a commonly accepted standard for data

centres. Some only count "carrier neutral" facilities, others count any data centre at which colocation may be purchased by a third party, and others count any facility that has a raised floor. It is for this reason that we have not presented a single consolidated set of figures for data centres in Africa. Nevertheless, it is clear that although data centres are still only present in a minority of countries in Africa, it is the fastest growing market in the world for these facilities, with demand outstripping supply by a factor of two or three.[94]

Data centre pricing is almost always more expensive in Africa than in more developed countries. One commercial report[95] lists 137 separate data centres in nine countries, operated by 65 providers. The countries are:

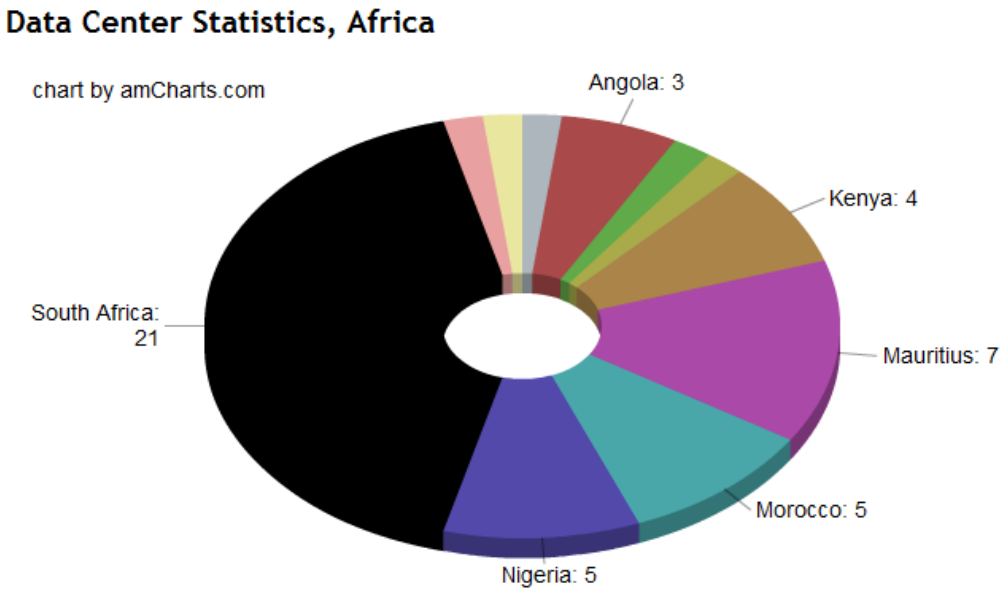
- Algeria
- Egypt
- Ghana
- Kenya
- Morocco
- Nigeria
- South Africa
- Tunisia
- Uganda

Data Center Africa[96] identifies 91 data centres in 16 countries, operated by 74 players. The report highlights Egypt, Kenya, Nigeria and South Africa as leaders in the development of regional data centres, achieving a faster level of growth than other countries included in the study.

Colocation Africa identifies 50 data centres from 11 countries[97] as shown in the image below:

[94] http://www.africantelecomsnews.com/Products/African_Data_Centres.html and http://www.itweb.co.za/index.php?option=com_content&view=article&id=153049 This subject alone is worth a report on its own, for future research
[95] http://www.datacentre.me/downloads/Documents/Data%20Centre%20Africa%202015%20Report%20-%20table%20of%20contents.pdf
[96] http://www.broad-group.com/reports/data-center-africa
[97] http://www.datacentermap.com/africa/

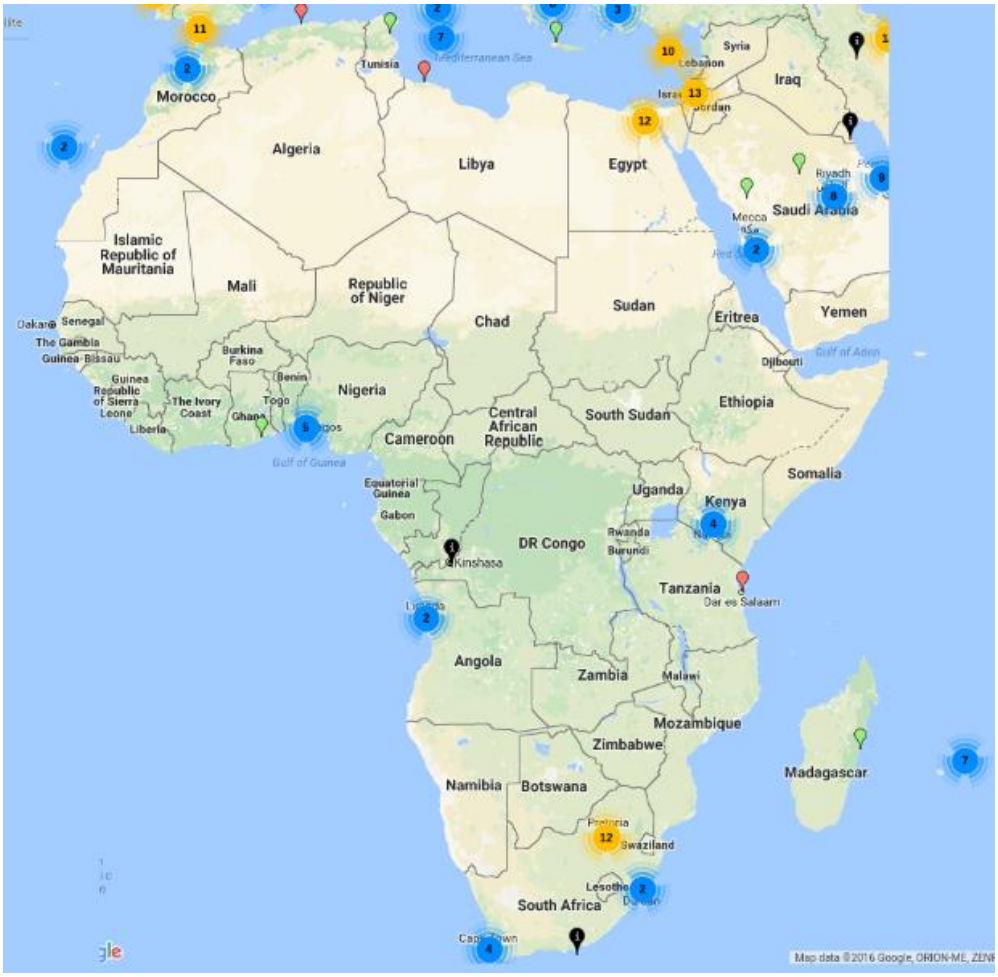
Figure 5-28: Colocation Africa Datacentre Distribution



Another source, Data Centre Research (DCR), a Danish consultancy, monitors the presence of "carrier neutral" data centres around the world and counts 60 in Africa, but these are concentrated in just 14 countries[98]. As shown in the map below the majority are located in South Africa (20), followed by Egypt (12), Mauritius (7), Nigeria (5), and Kenya (4) which have 48 between them. The remainder are in Angola, Algeria, Cap Verde, DRC, Ghana, Morocco, Tanzania and Tunisia. As would be expected, these are among the countries with the most vibrant exchange points and largest number of domain name registrations.

[98] DCR - http://www.datacentermap.com/

Figure 5-29: DCR Data Centre Map[99]



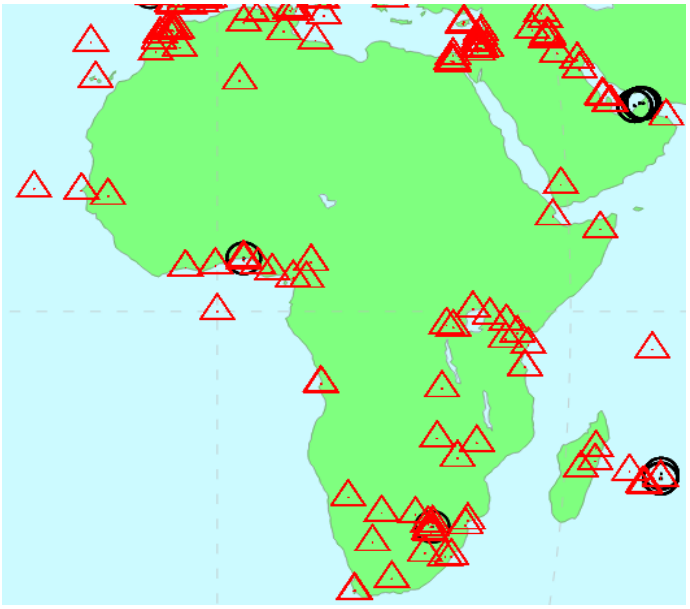
Local caching infrastructure and 'Content Distribution Networks' (CDNs), such as the Google Global Cache (GGC) and Akamai, which minimise upstream capacity requirements by eliminating the duplication of downloads of the same data, are now present in many locations in Africa. These servers are often installed at an IXP or inside a large access provider's network.

CDN operators usually lead the way, with Google often one of the first into a country with a cache server because of the major improvements in performance and distribution cost reduction achieved by caching the high volume of YouTube video data.

[99] Adapted from http://www.datacentermap.com/

The following map[100] shows the presence of GGC infrastructure in Africa identified by the University Of Southern California[101] (USC) in April 2016. As can be seen the caching infrastructure is clustered in four groups - one each in west, east, north and southern Africa, with very limited presence in the landlocked countries as yet.

Figure 5-30: Google Caching Infrastructure in Africa



5.4.4 IP Infrastructure

As indicated above in the section on IXPs, Autonomous System Numbers[102] and IP address space allocation provide an up-to-date picture of the level of development of Africa's Internet industry. As can be seen from the table below, Africa's use of Internet address space is far lower than any other region.

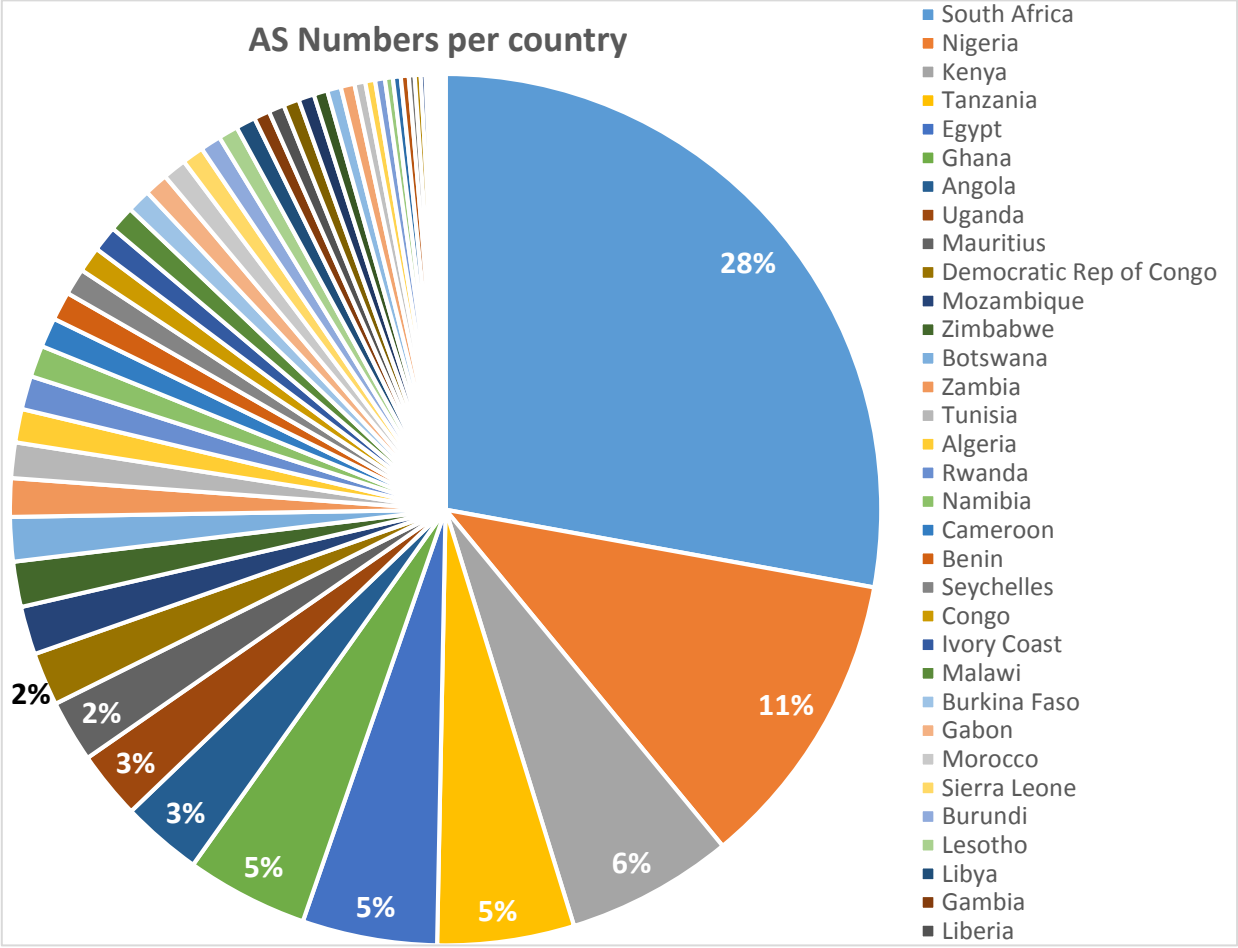
Table 5-3: Utilisation of IP Resources by Region[103]

Name	IPv4 ASNs	IPv4 ASNs	IPv6 ASNs	IPv6 ASNs
Americas	19 673	42%	2 802	33%
Asia	6 185	13%	1 115	13%
Europe	19 078	40%	4 136	49%
Oceania	1 397	3%	330	4%
Africa	792	2%	119	1%
Unclassified	2	0%	0	0%

[100] https://storage.uscnsl.net/mapping-google/public/google_data/2016-04/2016-04-23/mapv2-2016-04-23.pdf
[101] https://mappinggoogle.cs.usc.edu/
[102] An ASN is a globally unique index used to refer to all networks managed by one entity
[103] http://stats.labs.apnic.net/bgp

AS Numbers in particular are a good indicator of the development of independent networks in the country, as the more independent networks there are, the more ASNs will exist. The OECD pioneered the use of ASNs as a measure of the development of the Internet sector in their member states. The pie chart below shows that about two thirds of all African AS Numbers are concentrated in just 10 countries - South Africa, Nigeria, Kenya, Tanzania, Egypt, Ghana, Angola, Uganda, Mauritius, Democratic Rep of Congo.

Figure 5-31: AS Number Distribution

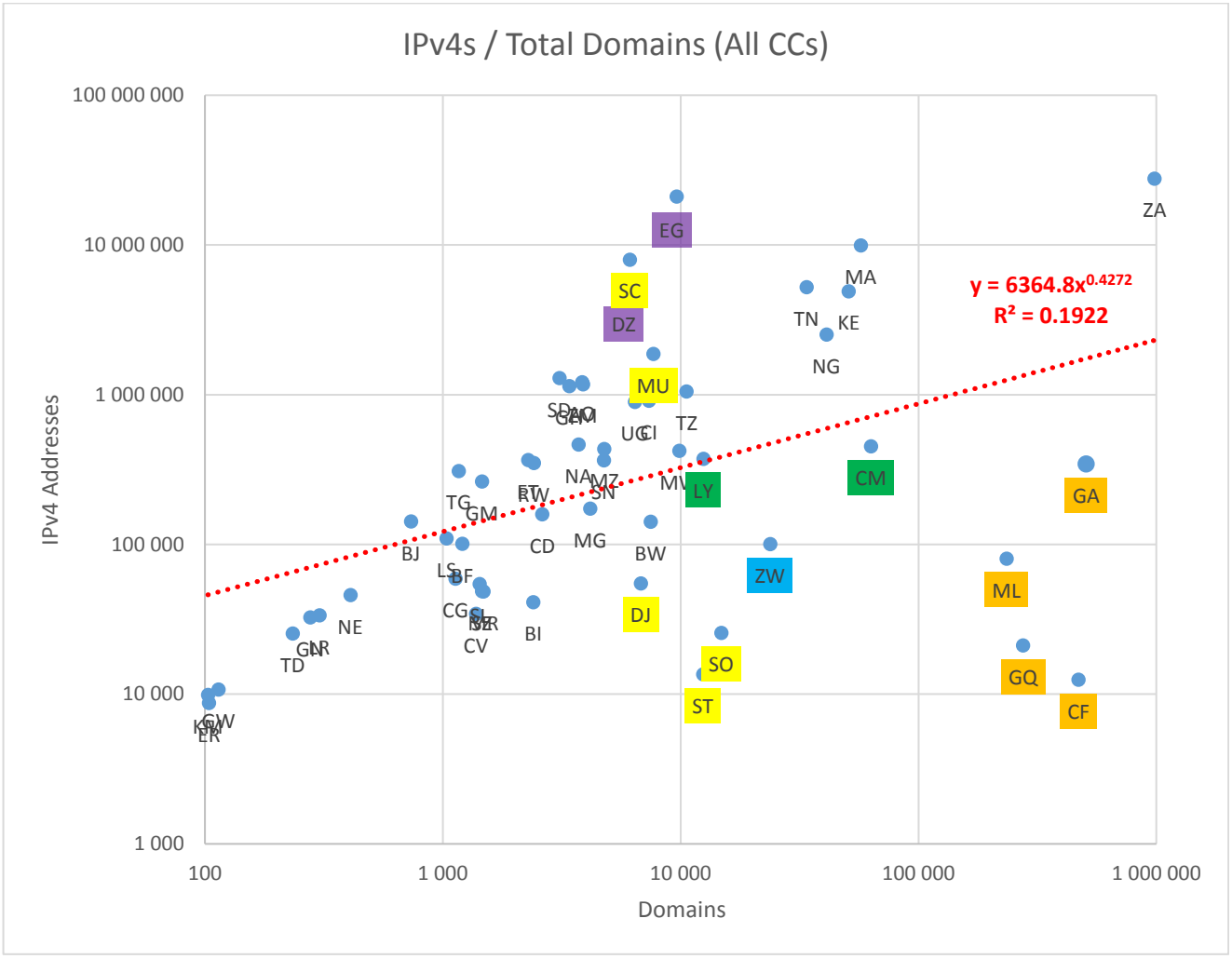


To examine the potential correlation between the number of Internet resources assigned to a country by AfriNIC and the number of domain names registered, the graph below plots the relationship between the number of IPv4 addresses[104] and domain names. Both axes are logarithmic.

[104] The uptake of IPv6 addresses in Africa is still very low indeed

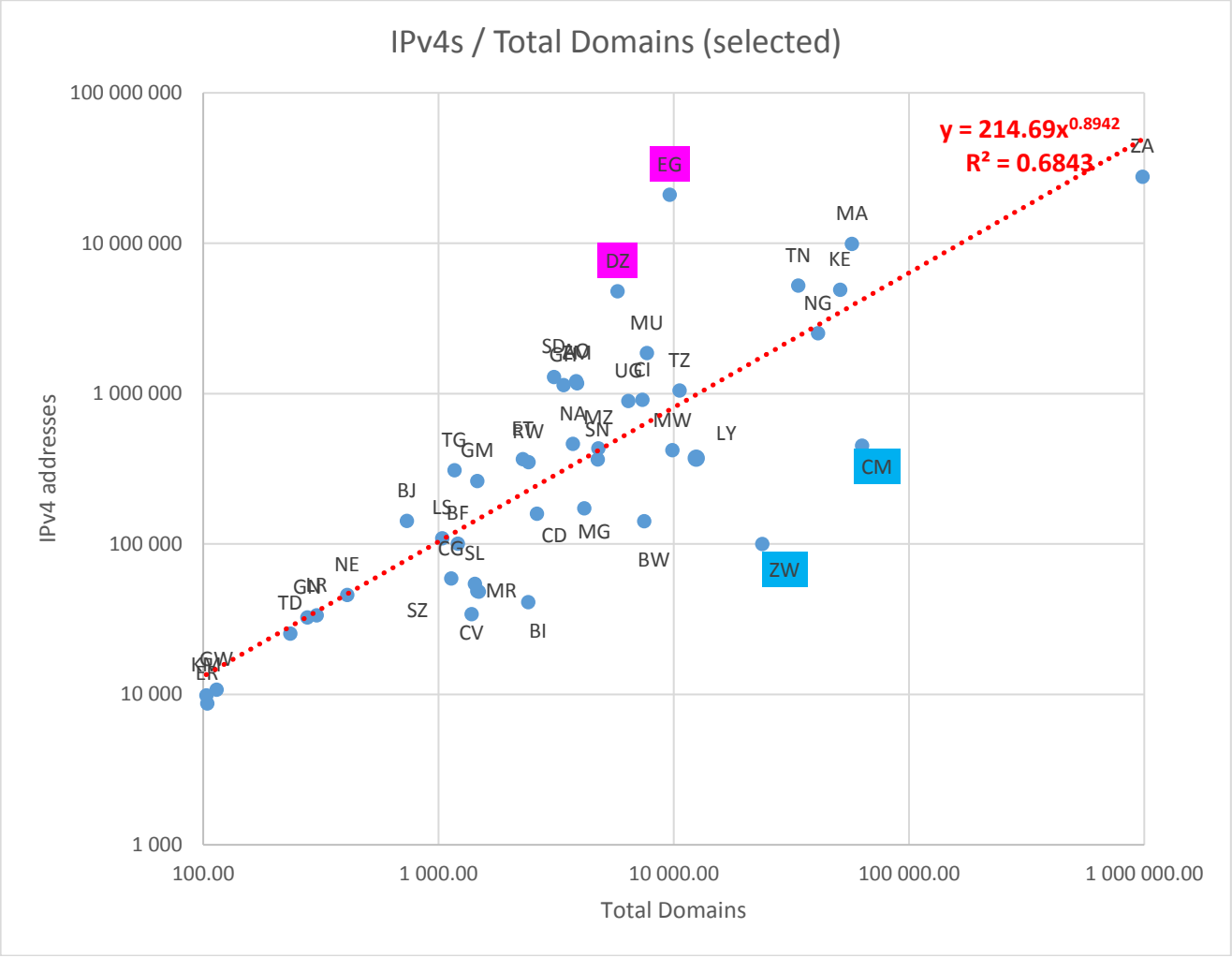
As can be seen, the four Freenom[105] domain hack countries (labels highlighted in Orange) are clearly atypical. A 'domain hack' is the additional use of a ccTLD for deriving third party advertising revenue, or for purposes more similar to the use of gTLDs, and as a result can make comparative analysis more difficult. These domains are discussed in detail in section 6.3.3. Other domain hacks are also highlighted in Yellow. Indeed, inclusion of any of the "domain hack" countries would distort the analysis, and are removed in the subsequent graphs.

Figure 5-32: IPv4 Allocations versus Domain Names – All Countries



[105] Freenom and Safecow are two registrars that offer free registration of a number of ccTLDs, including four in Africa

Figure 5-33: IPv4 Allocations versus Domain Names – Excluding Domain Hacks



By removing the outliers mentioned above, a reasonably good correlation between the number of IPv4 addresses and domains registered becomes apparent. The reasons why the highlighted countries: EG, DZ, ZW and CM are so far off the trend-line are discussed in sections 7.3 and 7.4. Removing them from the graph increases the correlation from 68% to 82%.

5.4.5 ISP Associations and IXPs

As the number of IXPs in Africa rose, so too did the number of ISP Associations (ISPAs). Indeed, they are intimately related. ISPs need an IXP in order to exchange traffic. They need an industry association to manage the IXP, and as a representative body for negotiating with government. During the first

ISPs need an IXP in order to exchange traffic efficiently

decade of this century, organisations such as AfrISPA[106] (amongst others) held training workshops in over 20 African countries. AfrISPA not only conducted training courses on the technical, economic, regulatory and political aspects of IXP formation, but also conducted simultaneous courses on industry association formation. During this period, the number of IXPs rose from five to 22, with a similar increase in the number of ISPAs. IXP formation is a process strongly influenced by industry politics– it is often said that it is 10% technology and 90% politics. For example, the establishment of Benin's IXP took eight years of negotiations from initial agreement in 2005 to full operation in 2013.

Africa has experienced – and in many cases is still experiencing – a considerable liberalisation of the telecommunications market. In most countries the state-owned monopoly fixed line operator no longer has absolute power over internal and external communications. This liberalisation process has not been without its growing pains. In most African countries ISPs are licensed. As a result, if an ISP was too outspoken in opposition to government policy or regulations, such opposition might result in risk to its business. By forming an ISPA or other industry association when the ISPA representative speaks, it does so on the behalf of an entire industry, and not simply as an individual or as a representative of a company. This reduces both personal and corporate risk.

To an increasing extent policy makers and regulators in many African countries take their industry associations seriously, and actively solicit their views before promulgating new regulation or legislation. This is a very welcome development, and bodes well for countries that adopt this approach.

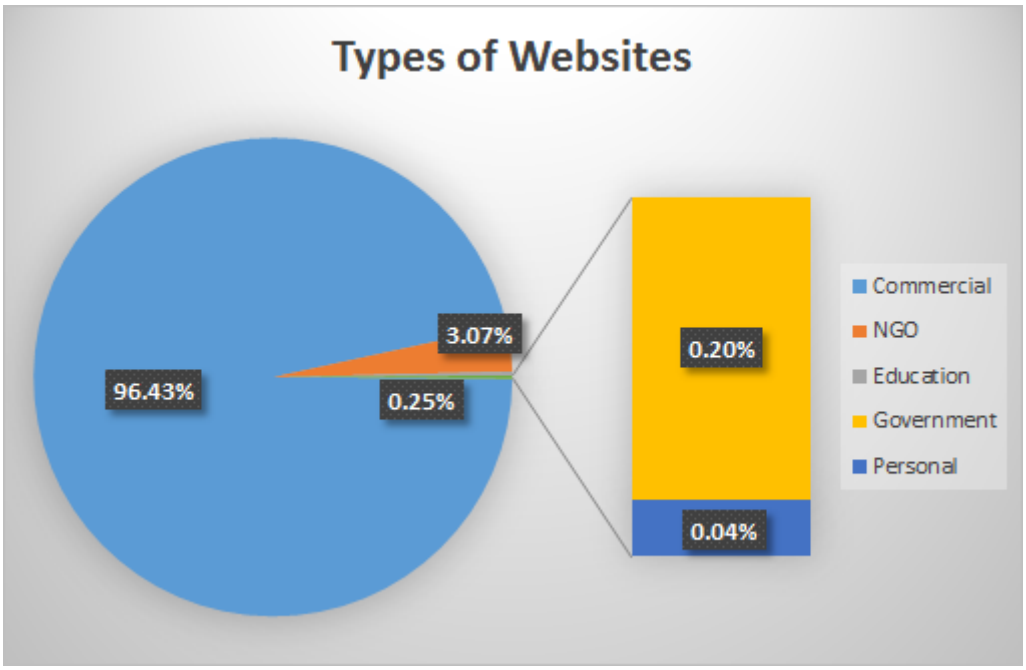
5.5 Content and the African DNS

5.5.1 Types of Content Hosted

As a means of identifying the various types of content hosted under African DNS, the domains registered under second levels were categorised. For those zone files that were made available to analyse, domains were characterised as commercial, NGO, educational, government and personal. This produced a range from 1.1 million commercial domains down to a few hundred personal domains, as shown graphically in the expanded pie chart below, for the 10 countries for which detailed figures were available.

[106] The African Association of ISP Associations. Now defunct.

Figure 5-34: Types of Website



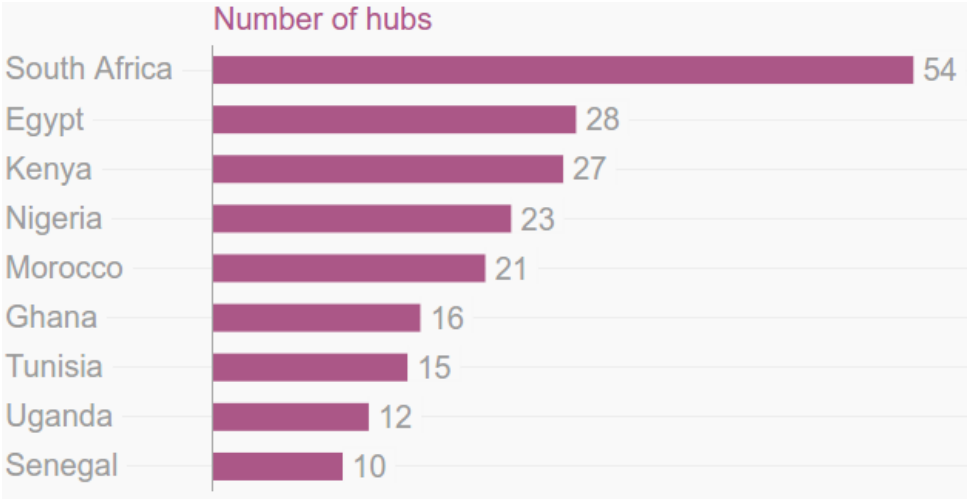
It is quite clear that the vast majority of the content analysed was commercial in nature.

5.5.2 Digital Entrepreneur Development

Demand for local domains is often driven by application developers who need to access affordable high bandwidth network services and to share other resources, ideas and contacts to build their businesses. These needs are increasingly being met in Africa through the development of technology hubs and incubators, which provide shared office space and other resources where start-up IT-enabled businesses can be supported, developed and launched into the market. The importance of these facilities is underscored by the recent Ecosystem Accelerator survey conducted by mobile telecom industry body GSMA, which found a total of 314 tech hubs and incubation centres in Africa in July 2016[107]. The hubs are spread across 93 cities in 42 countries across the continent. However, most hubs are still relatively young (average year of formation is 2012) and more than half are concentrated in only five countries, namely: South Africa, Egypt, Kenya, Nigeria and Morocco.

[107] http://www.gsma.com/mobilefordevelopment/programme/ecosystem-accelerator/things-learned-tech-hubs-africa-asia

Figure 5-35: Technology Hubs and Incubation Centres



5.5.3 SMEs and E-Commerce

Although data on SMEs in Africa is limited, there are an estimated 40 million micro, small and medium enterprises on the continent[108], and their importance is widely acknowledged. For example, about 96% of Nigerian businesses are SMEs, according to statistics from the Central Bank of Nigeria.

Most SMEs operate informally, and are unlikely to have registered their own domain or use e-commerce services. Instead they are more likely to use mobile text messaging, mobile payments and possibly an email address from a free service such as Gmail or MSN. A few may even have a Facebook page. While the authors are not aware of any specific surveys carried out in Africa, this market is likely to represent a large potential unmet demand for domain names, as some of these businesses move into the formal economy.

The extent to which this takes place largely depends on the effectiveness of fiscal authorities in making it simpler and more attractive for SMEs to enter the formal economy through more streamlined business registration procedures. A big incentive in this regard will be the ability to win more business through e-commerce.

Currently, the use of e-commerce by SMEs remains low. The current share of consumer e-commerce by African enterprises, for example, is below 2%, but has 'enormous potential',

[108] http://africanbusinessmagazine.com/african-banker/exchanges-give-smes-helping-hand/#sthash.RvzB2kks.dpuf

estimates Intracen[109], which predicts that by 2018, the African e-commerce market will reach USD $50 billion, from just USD $8 billion in 2013. The banking sector will also need to be more conducive to small businesses, especially when receiving international payments is a key part of trade, whether online or offline. In countries with restrictive regulations governing cross-border transactions that involve foreign currencies, and without access to an international bank account or credit card, enterprises may have less incentive to put up websites and domains listing their products and services.

To be successful SMEs also need to better understand the markets they are serving, whether they are local or international, and be able to readily access those markets. This can be facilitated by, among other things, more reliable and affordable broadband infrastructure, and a regulatory framework that takes SMEs' specific circumstances into account.

Registrars should offer website hosting packages with domain registration

Finally, it should also be pointed out that Registrars have an important role to play in making SMEs aware of the potential for registering domains and should combine these with appropriate website hosting packages and applications to help them build their online presence.

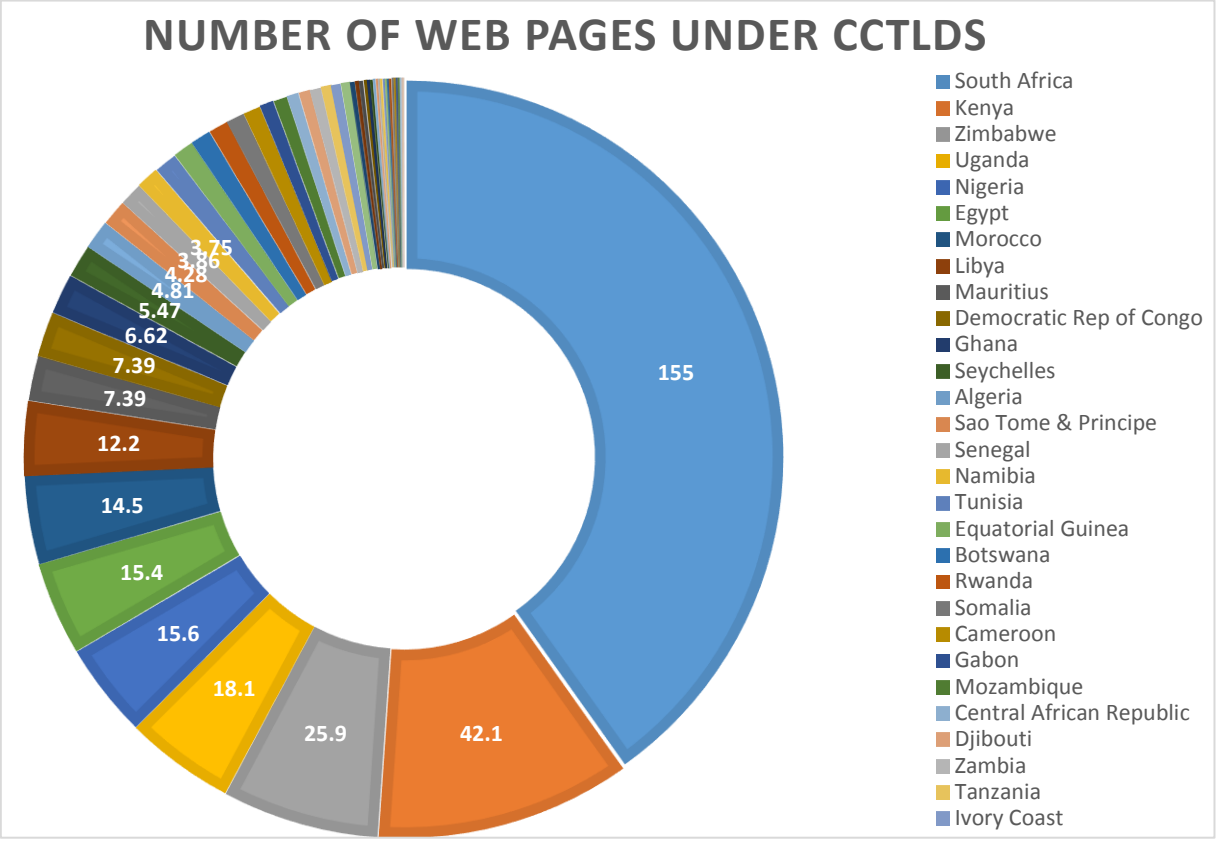
5.5.4 Volumes of Content by Country

Increasing local content increases the demand for local domain names. The development of e-government services, the presence of e-commerce and payment gateways, and digital literacy have large roles to play in demand and supply of local content. These factors vary considerably between different countries, and combined with the infrastructure variations described above, has resulted in African web pages being concentrated among just a few ccTLDs.

As shown in the chart below, over three quarters of the almost 400 million web pages with African ccTLD URLs indexed by Google are located in just seven Countries - South Africa, Kenya, Zimbabwe, Uganda, Nigeria, Egypt and Morocco. South Africa and Kenya together are responsible for over 50% of these web pages.

[109] http://www.intracen.org/uploadedFiles/intracenorg/Content/Publications/International%20E-Commerce%20in%20Africa_Low-res.pdf

Figure 5-36: Millions of Webpages under African ccTLDs



When population size is taken into account most of the same countries are indicated, although the spread is a little broader. The table below divides the total web pages tracked by Google by the 2015 population, with just 14 countries found to have more than 0.5 pages per capita[110].

[110] Source: World Bank, Google.com Nov 2016

Table 5-4: Indexed Web Pages per capita

Country	Population	Google Web Pages Indexed under ccTLD Nov 5 2016	Pages / capita
Seychelles	92,430	5,470,000	59.2
Sao Tome & Principe	194,006	4,280,000	22.1
Mauritius	1,339,827	7,390,000	5.5
Equatorial Guinea	759,451	3,450,000	4.5
South Africa	54,777,809	155,000,000	2.8
Djibouti	846,687	1,920,000	2.3
Libya	6,411,776	12,200,000	1.9
Zimbabwe	14,229,541	25,900,000	1.8
Namibia	2,212,307	3,750,000	1.7
Botswana	2,209,208	3,360,000	1.5
Gabon	1,738,541	2,300,000	1.3
Cape Verde	553,432	679,000	1.2
Kenya	45,925,301	42,100,000	0.9
Uganda	37,101,745	18,100,000	0.5

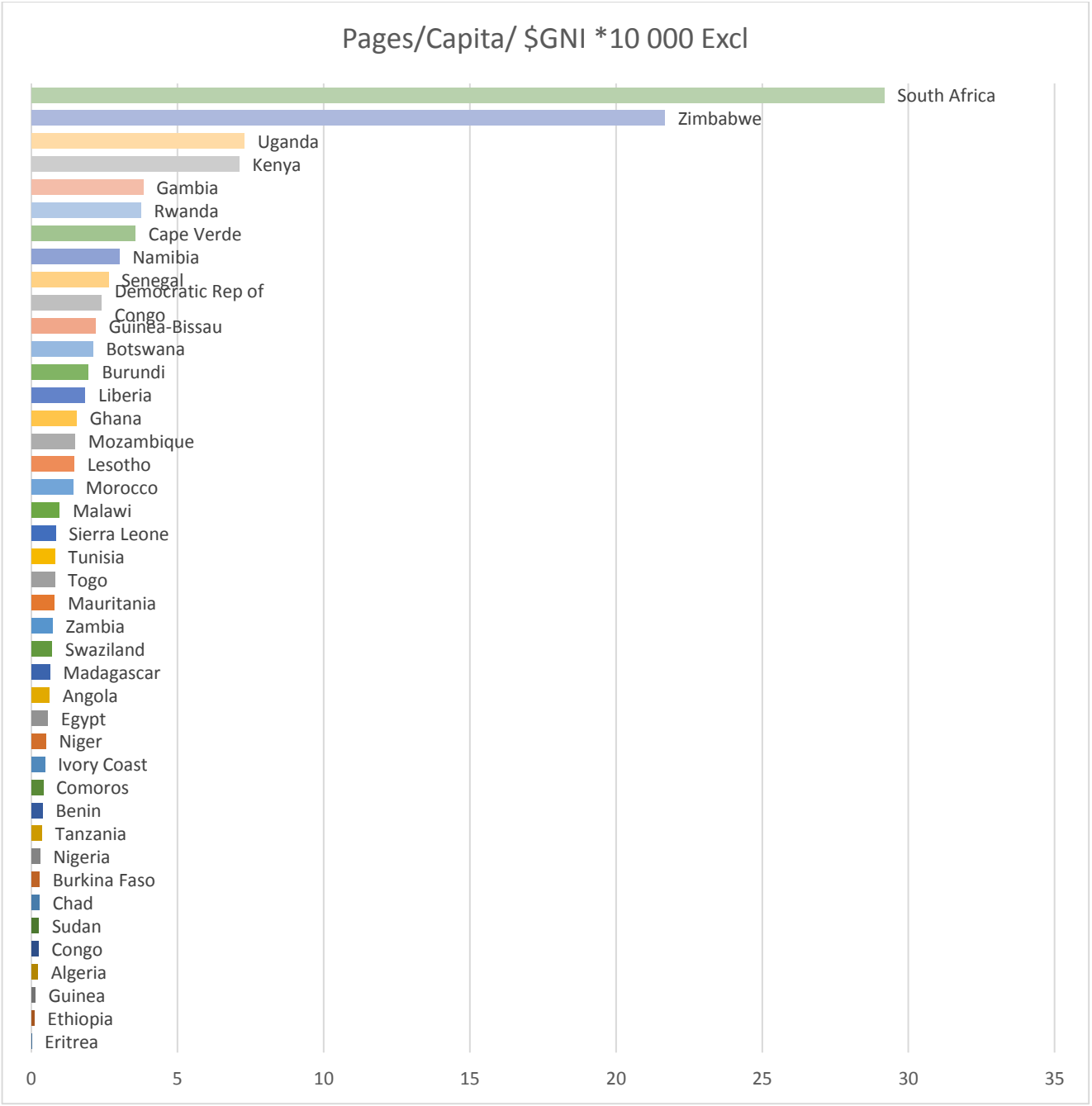
However, of these, seven are "domain hacks" (see section 6.3.3, where the high use of domain names by entities unrelated to the country is discussed). Excluding these gives a much shorter list of countries – only seven countries in Africa have more than 0.5 web pages / capita, as shown in the table below.

Table 5-5: Indexed Web Pages per capita, excluding domain hacks

Country	Population	Google Web Pages Indexed under ccTLD, Nov 5 2016	Pages / capita
South Africa	54 777 809	155 000 000	2.83
Zimbabwe	14 229 541	25 900 000	1.82
Namibia	2 212 307	3 750 000	1.70
Botswana	2 209 208	3 360 000	1.52
Cape Verde	553 432	679 000	1.23
Kenya	45 925 301	42 100 000	0.92
Uganda	37 101 745	18 100 000	0.49

The chart below lists the number of websites per country, while also taking into account the wealth of the country (GNI / capita), as well as population size. By removing 'domain hack' countries, it is possible to see more clearly the different levels of use of African domains for website purposes.

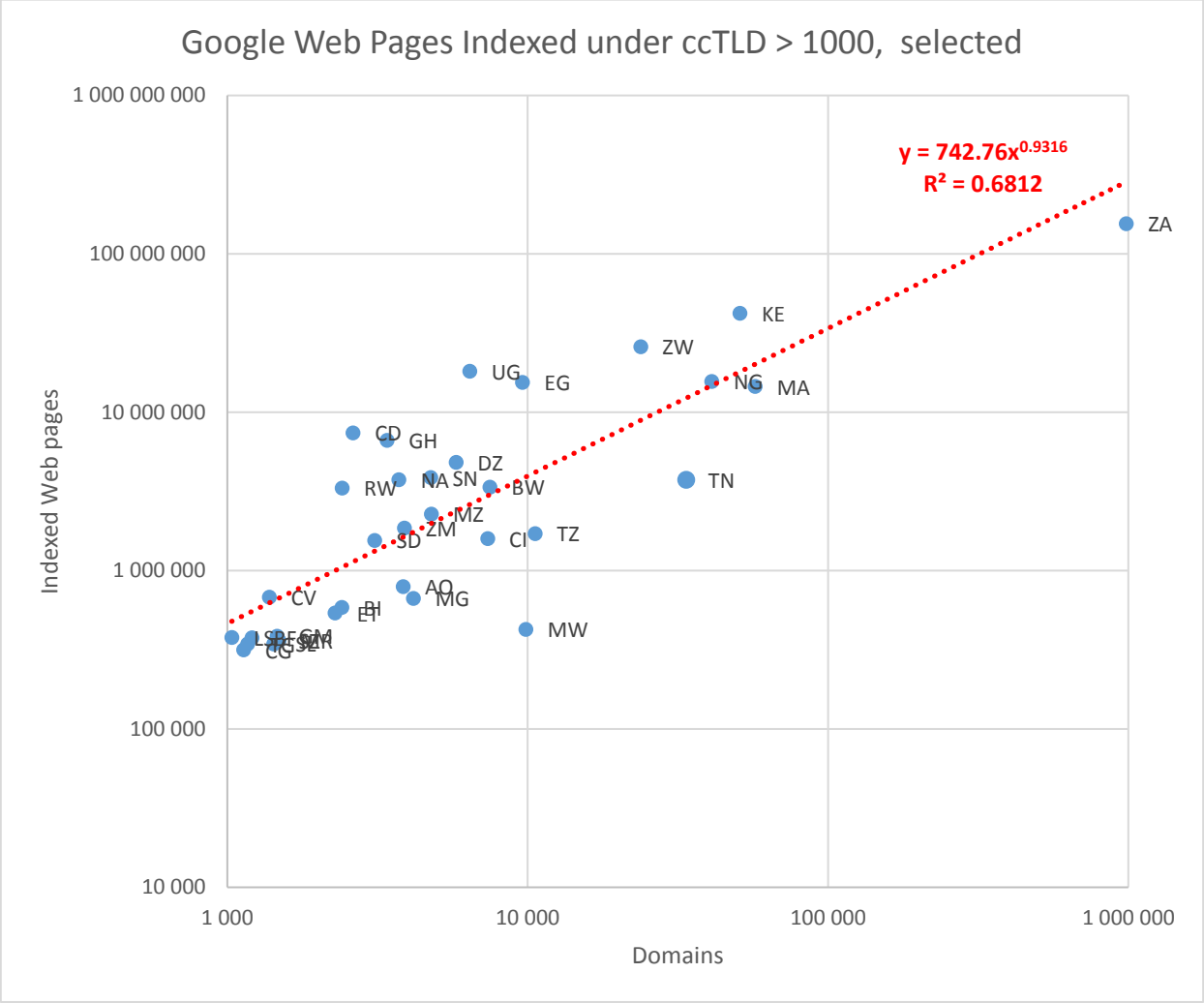
Figure 5-37: Indexed Web Pages per capita, Normalised



As the chart above indicates, the top 10 countries in Africa with the largest web page presence per Gross National Income (GNI) per capita are (in order): South Africa, Zimbabwe, Uganda, Kenya, Gambia, Rwanda, Cap Verde, Namibia, Senegal and Botswana. This measure of the volume of local content is an important indication of the vibrancy of the Internet ecosystem in these countries.

A plot of the total number of domains and the number of indexed web pages gives a moderate level of correlation as shown in the graph below. Only those countries where there are more than 1,000 domains are included.

Figure 5-38: Indexed Web Pages versus Domains



5.5.5 Offshore and On-Continent Hosting

To study the hosting location of African content, analysis took place of 19 zone files from four African countries, plus the three South African .CITY gTLDs, as well as an extract of gTLD domains with an African Registrant from a large international Registrar and from a domain analysis house. These were kindly provided to us by Afilias and EyeDomain, respectively. For a complete analysis more zone files and extracts are needed. Unfortunately, the researchers only had access to ccTLD zone files from four countries. The level of cooperation was very low. No WHOIS lookups or identification of individuals were required by the Study Team in order to produce the analysis presented here.

5.5.5.1 Afilias gTLD Domains

Afilias was able to provide us with three pieces of data about 147,000 domains in 21 gTLDs. The data consisted of a Domain Name, a Creation Date and the African country with which the Registrant is associated. The data was analysed without any WHOIS lookups by the Study Team (other than Geo-Location for the IP address) and we did not obtain, have, process or require any personal information about the Registrant.

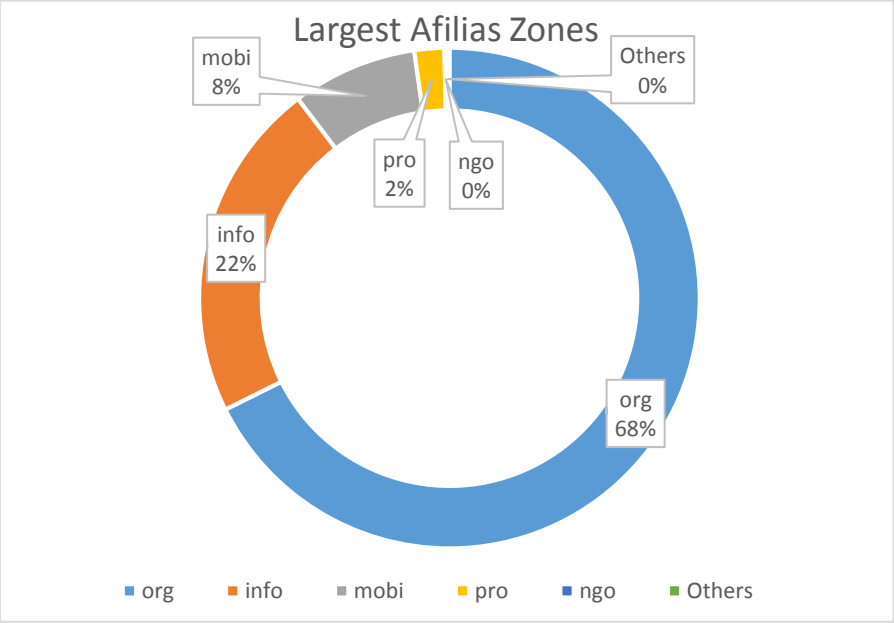
Of the domains provided 77% pointed to a web server and 52% had websites with significant content[111]. 3% of the domains were configured with IPv6 and 0.2% with DNSSEC. All 54 African countries were represented, including two domains with registrants from Southern Sudan (SS), even although its ccTLD has not been delegated yet.

The Study Team did no WHOIS lookups

Although there were 21 gTLDs involved, 98% of the domains were concentrated in just three zones: .ORG, .INFO and .MOBI. Note that the biggest gTLD zone, .COM, isn't included in this sample. A summary of the data is shown in the following graphics.

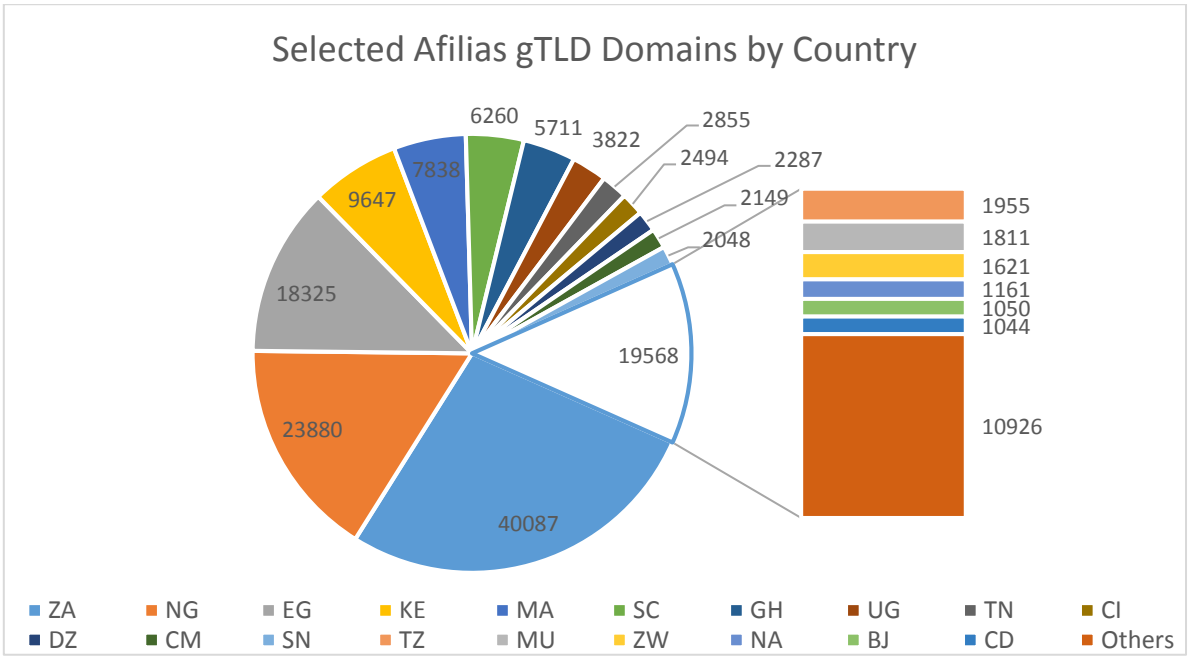
[111] We counted a "real" website as one that has more than 2000 characters returned from the root document, as well as at least five internal links, to ensure we weren't looking at a single page "place holder" website

Figure 5-39: Afilias gTLD Zone Size Distribution



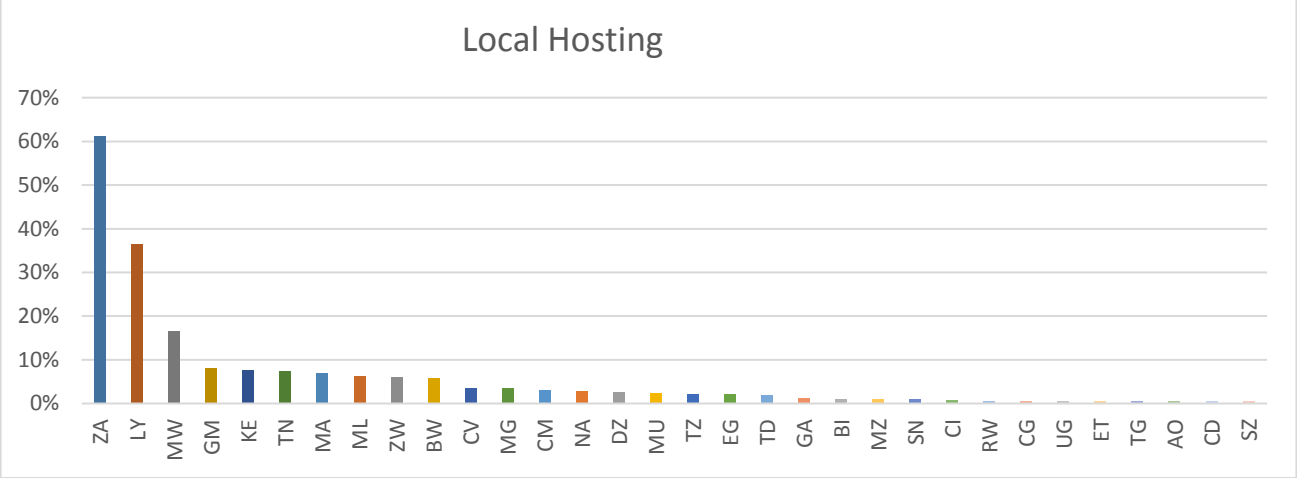
Of the 146,989 Afilias domains, 40,087 were associated with South Africa, followed by 23,880 with Uganda, 18,325 with Egypt, 9,647 with Kenya and 7,838 with Morocco. The complete distribution is shown below.

Figure 5-40: Distribution of Afilias gTLDs by Country



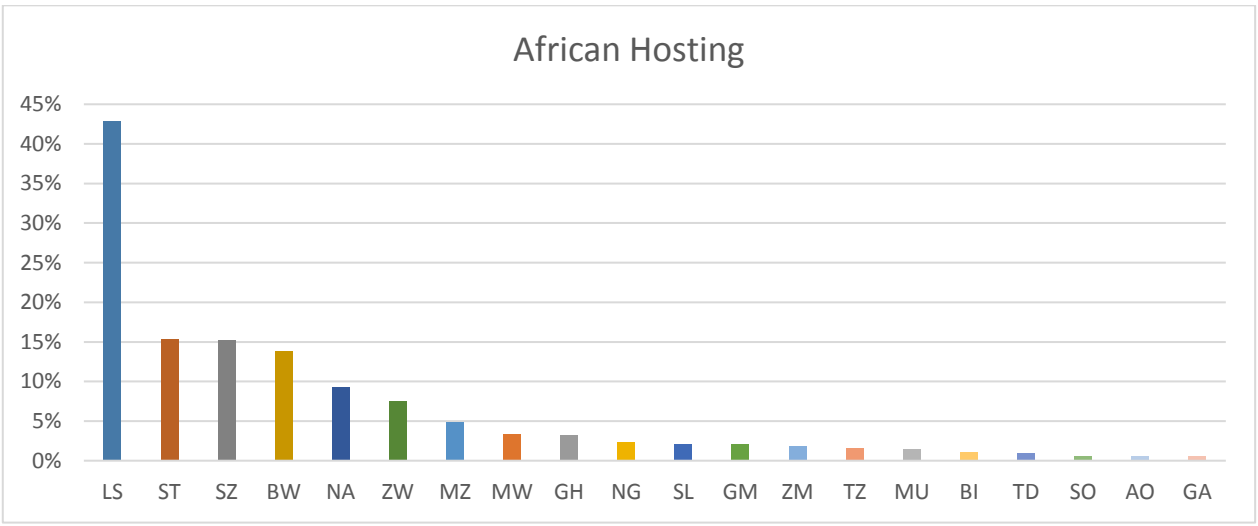
South Africa hosts 61% of its Afilias domains locally, followed by Libya with 37% (38 out of 104) websites hosted locally, and then Malawi at about 17%. Guinea, Kenya, Tunisia, Morocco, Mali, Zimbabwe and Botswana then all follow, at about 6-8%. The overall distribution is shown in the pie chart below. The presence of some countries such as Guinea and Mali, which are not known for their local hosting facilities, may be an artefact of the sampling method and the small sample size.

Figure 5-41: Local Hosting of Afilias gTLDs



Moving on to those Afilias websites hosted by another African country, Lesotho leads with 43%, all of which are hosted in South Africa. Other smaller African countries follow: Sao Tome & Principe, Swaziland, Botswana and Namibia. The overall distribution is again in the bar chart below.

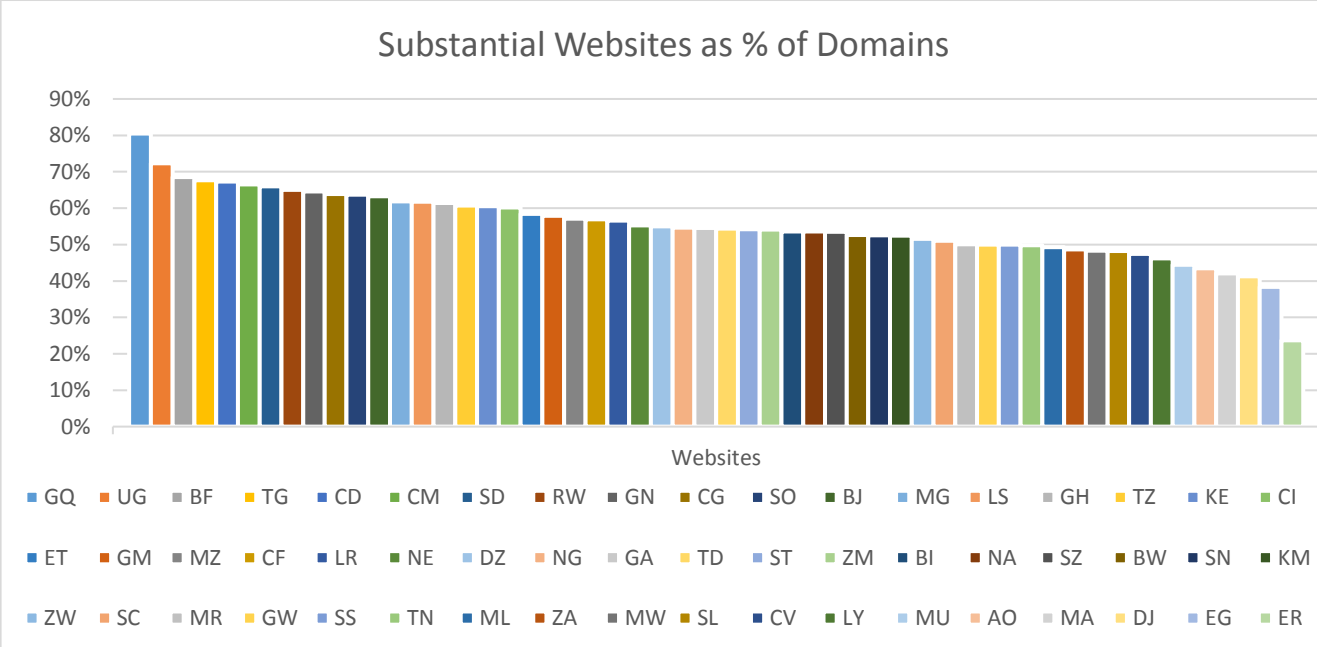
Figure 5-42: African Hosting of Afilias gTLDs



In terms of overseas hosting, 15 countries hosted 100% of their Afilias gTLD websites overseas and another 24 countries hosted over 95% of websites overseas. This is indicative of the very low levels of local hosting – and hence Internet ecosystem health – in a majority of African countries.

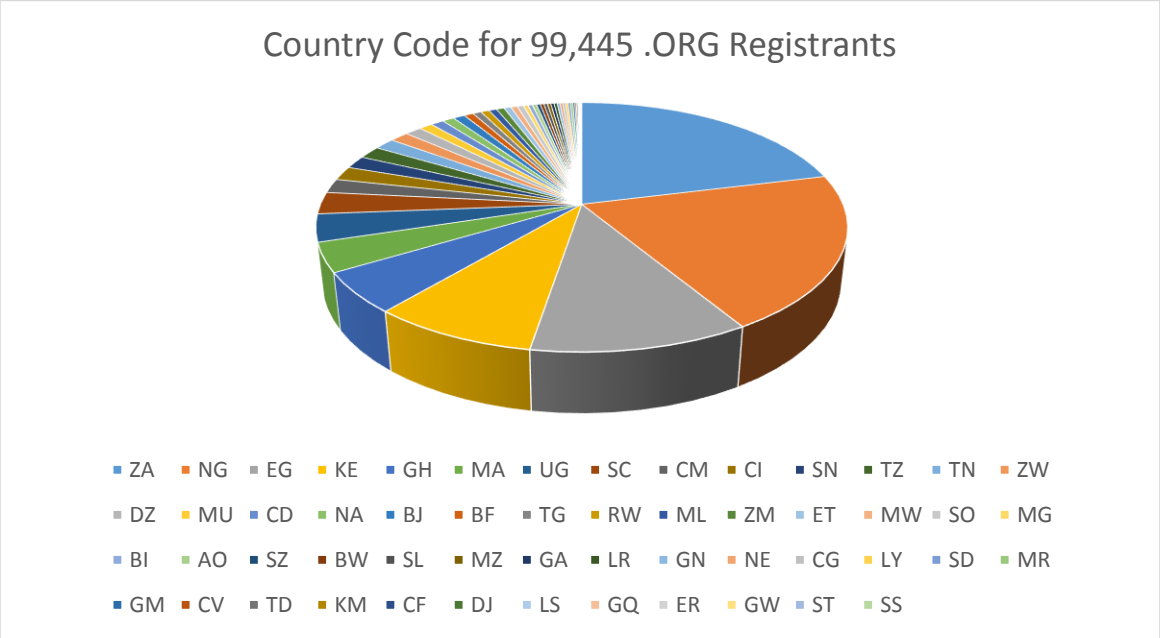
Of those who have registered an Afilias domain there is a reasonably high proportion of websites operating on those domains (i.e. not squatted, or just used for email), ranging from 81% (128 out of 159) for Equatorial Guinea, to 72% for Uganda and 69% for Malawi. The distribution is again shown below.

Figure 5-43: Domain Usage



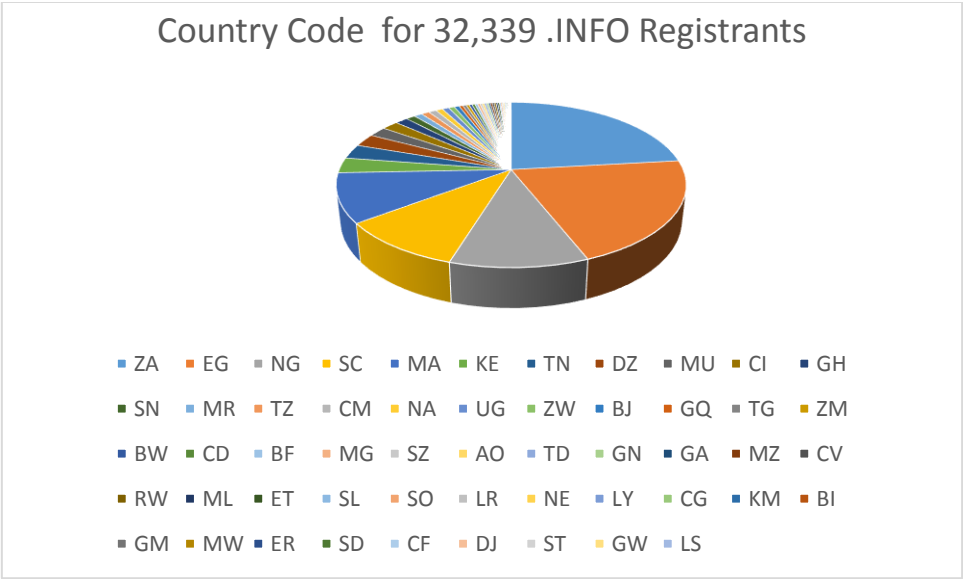
Looking at individual zones, the largest of these was the .ORG zone (99 445 African domains), with most domain registrants from South Africa, followed by Nigeria, Egypt, Kenya and Ghana.

Figure 5-44: .ORG Domain Distribution



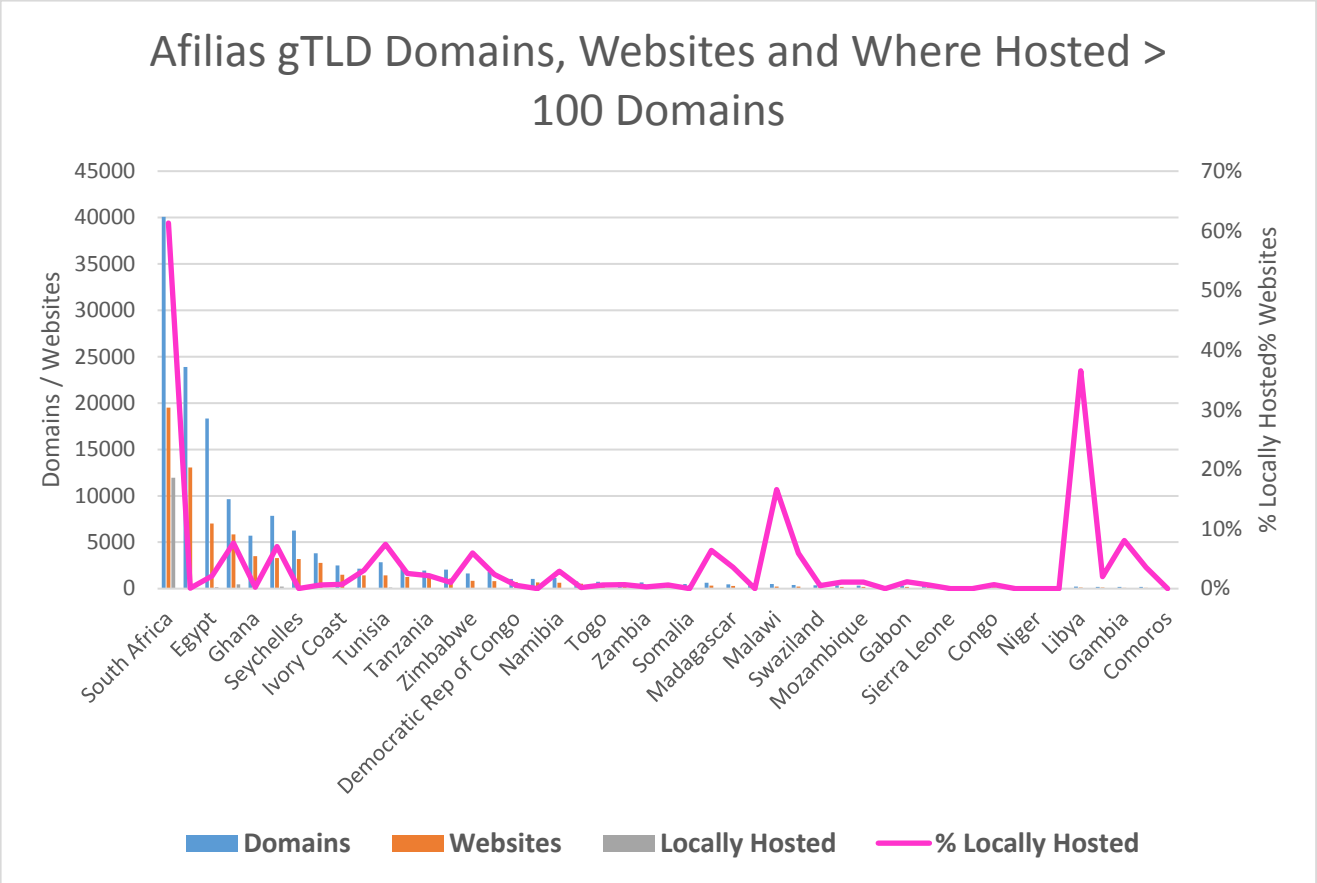
The order changed slightly for the second largest Afilias zone, .INFO (32 339 African domains). South Africa leads again, followed by Egypt, Nigeria, Seychelles and Morocco.

Figure 5-45: .INFO Domain Distribution



The chart below shows how many domains are registered, how many have websites, how many websites are locally hosted and the percentage of websites locally hosted, for those African countries that have more than 100 Afilias gTLD domains registered.

Figure 5-46: Afilias gTLD Infographic



The ranking of the Top 10 countries by number of Afilias gTLD domains; the highest total number of websites; and the highest proportion of locally hosted gTLD domains is shown in the table below.

Table 5-6: Ranking by Afilias Domains

Total Afilias Domains	Total Websites	% Locally Hosted
South Africa	South Africa	South Africa
Nigeria	Nigeria	Libya
Egypt	Egypt	Malawi
Kenya	Kenya	Gambia
Morocco	Ghana	Kenya
Seychelles	Morocco	Tunisia
Ghana	Seychelles	Morocco
Uganda	Uganda	Mali
Tunisia	Ivory Coast	Zimbabwe
Ivory Coast	Cameroon	Botswana

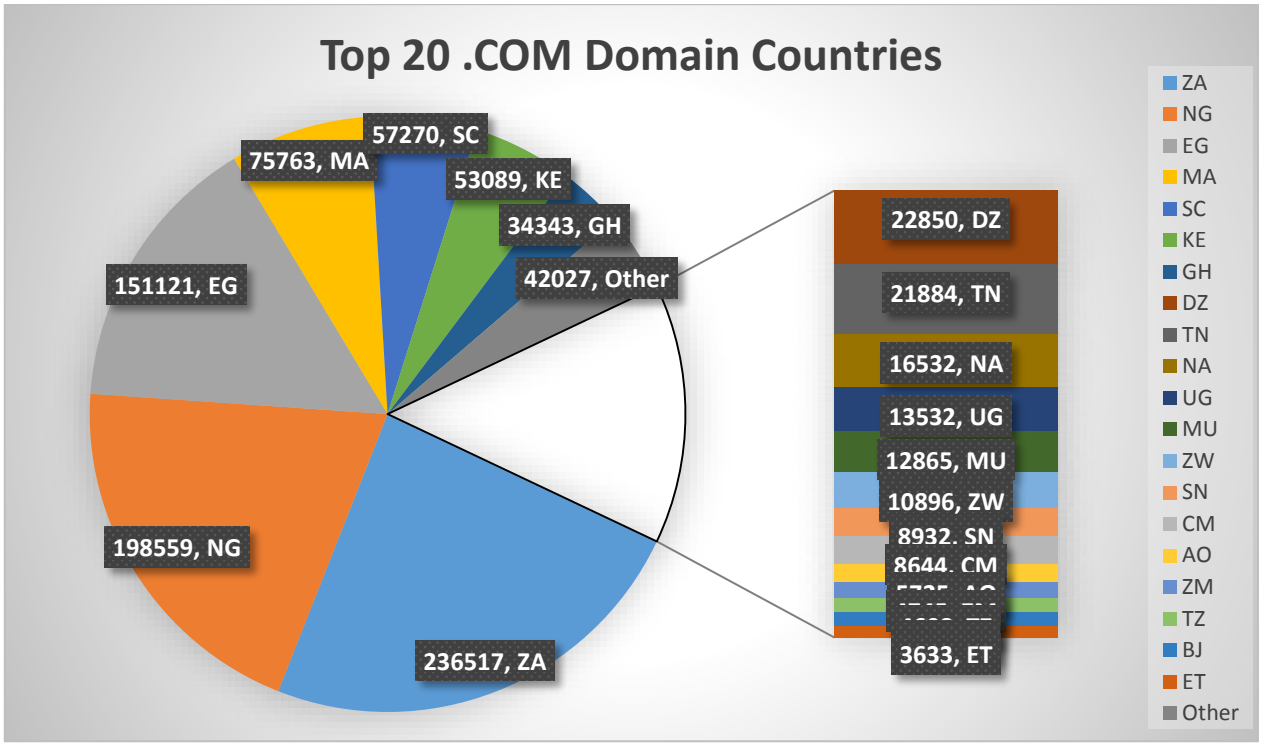
5.5.5.2 EyeDomain gTLD Domains

EyeDomain was also able to provide us with three pieces of data about 988,000 domains in the .COM gTLD, which consisted of a Domain Name, a Creation Date and the African country with which the Registrant is associated. The data was analysed by the Study Team without any further WHOIS lookups (other than Geo-Location for the IP address) and we did not obtain, have, process or require any personal information about the Registrant.

Of the domains provided 52% had websites with significant content. 0.4% of the domains were configured with IPv6 and 0.32% with DNSSEC. Only 51 African countries were represented, with no .COM domains identified from Southern Sudan (SS), Ivory Coast (CI) and Guinea-Bissau (GW).

A summary of the data is shown in the following graphics. Of the 987,610 EyeDomain domains, 236,517 were associated with South Africa, followed by 198,559 with Nigeria, 151,121 with Egypt, 75,763 with Morocco and 57,270 with the Seychelles. The distribution of the top 20 countries is shown below.

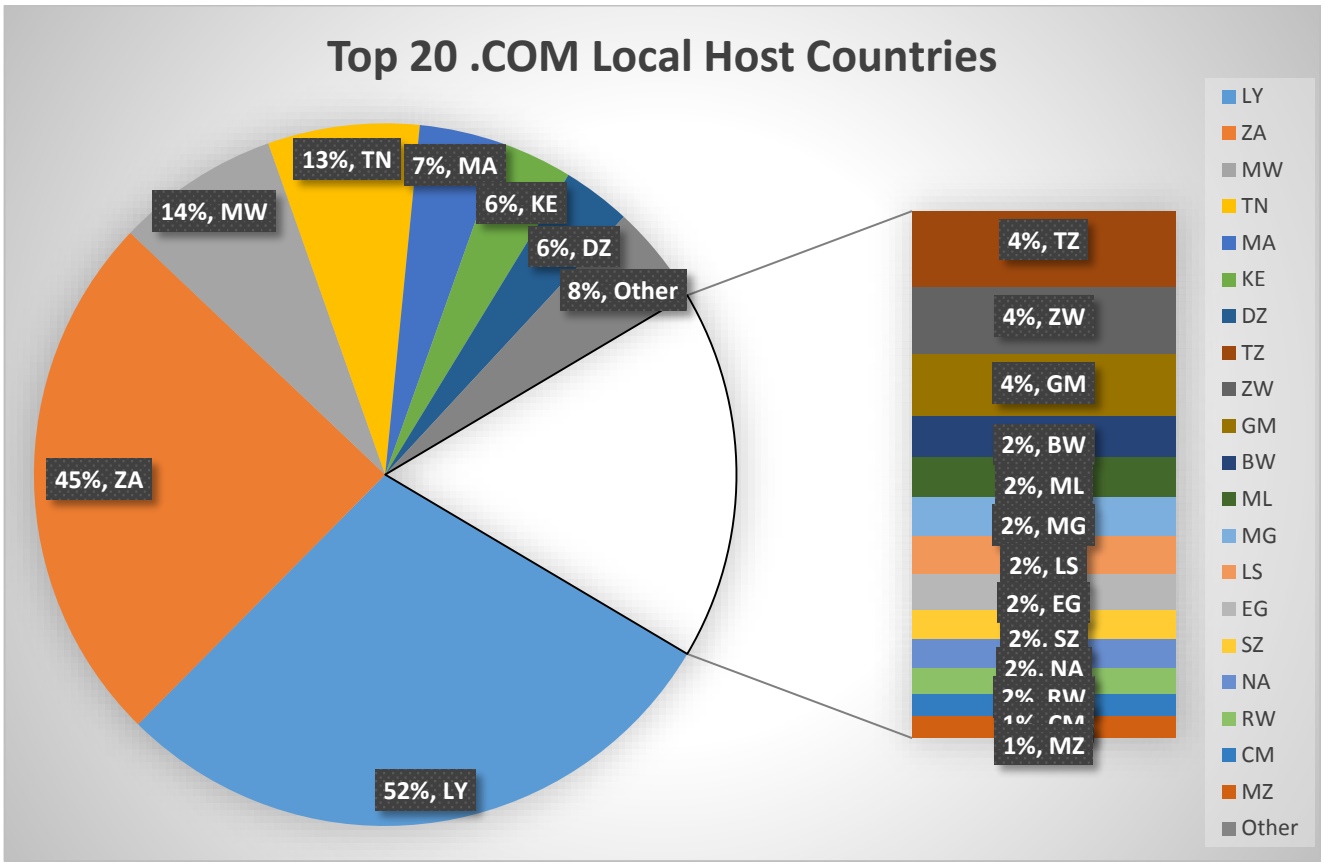
Figure 5-47: .COM Domain Distribution



Libya hosts 52% (522 out of 1006) of its .COM domains locally, followed by South Africa with 45%, Malawi at about 14% and then Tunisia at 13%. Morocco, Kenya and Algeria then all follow, at

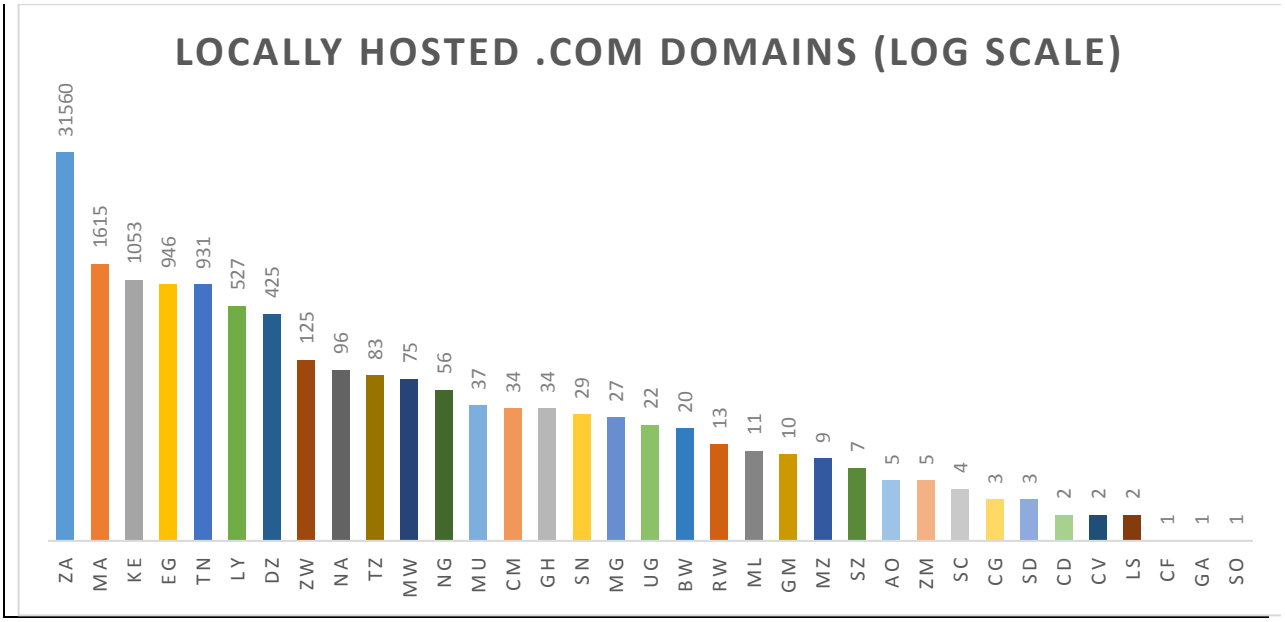
about 6-7%. The overall distribution is shown in the pie chart below. The presence of some countries such as Malawi and Tanzania, which are not known for their local hosting facilities, may be an artefact of the sampling method and the small sample size.

Figure 5-48: .COM Local Hosting



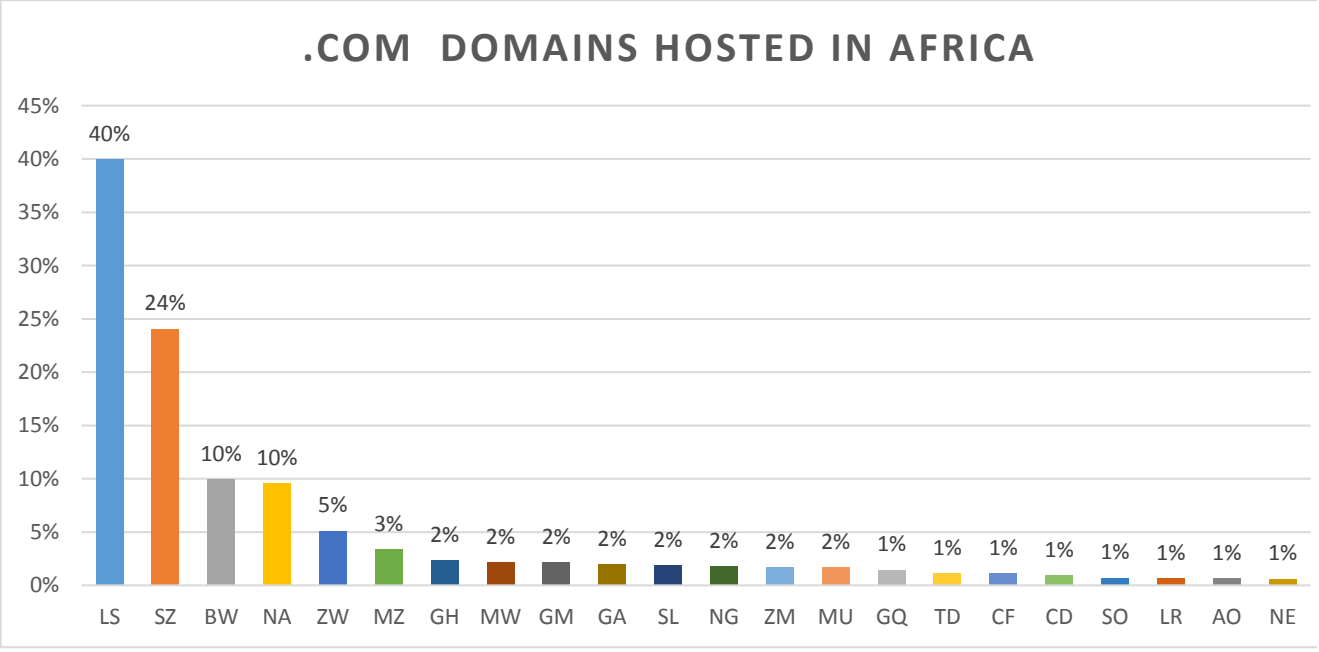
With such large differences in scale, the logarithmic chart below shows the numbers of domains hosted by each country, for the 35 countries identified with at least one locally hosted domain.

Figure 5-49: .COM Local Hosting (Log Scale)



Moving on to those EyeDomain .COM websites hosted by another African country, Lesotho leads with 40%, all of which are hosted in South Africa. Other smaller African countries follow: Swaziland, Botswana, Namibia and Zimbabwe. The overall distribution is again in the bar chart below.

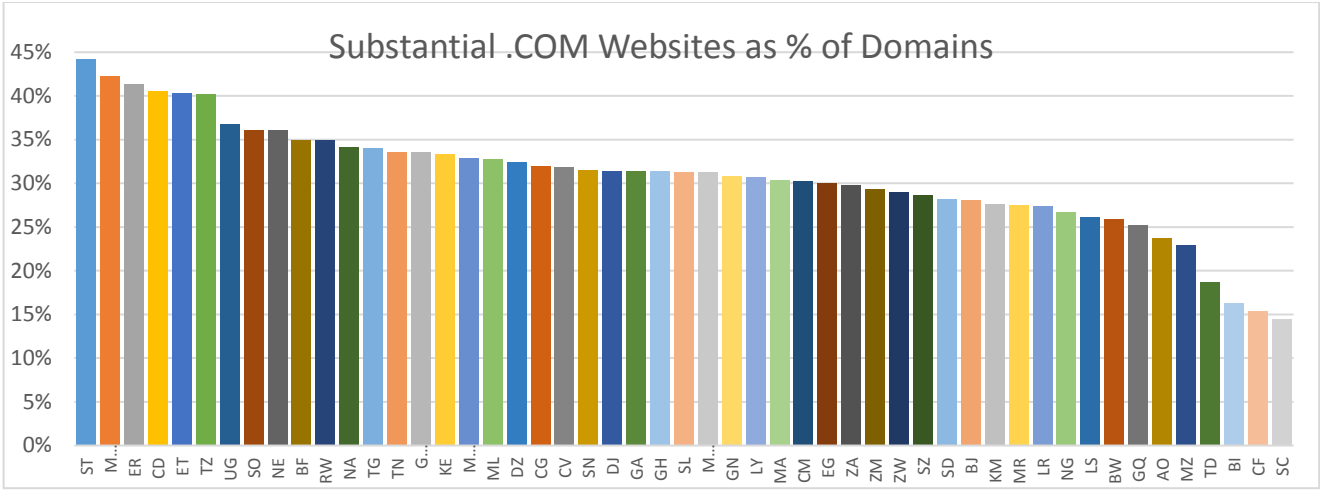
Figure 5-50: .COM Websites Hosted in Other African Countries



In terms of overseas hosting, 12 countries hosted 100% of their EyeDomain .COM websites overseas and another 24 countries hosted over 95% overseas. This is indicative of the very low levels of local hosting – and hence Internet ecosystem health – in a majority of African countries.

Of those who have registered an EyeDomain .COM domain there is a reasonably high proportion of websites operating on those domains (i.e. not squatted, or just used for mail), ranging from 44% (27 out of 61) for Sao Tome & Principe, to 42% for Madagascar and 41% for Malawi. The distribution is again shown below.

Figure 5-51: Usage of .COM domains



The ranking of the Top 10 countries by number of EyeDomain .COM domains, the highest total number of websites and the highest proportion of locally hosted gTLD domains is shown in the table below.

Table 5-7: .COM Domain Ranking

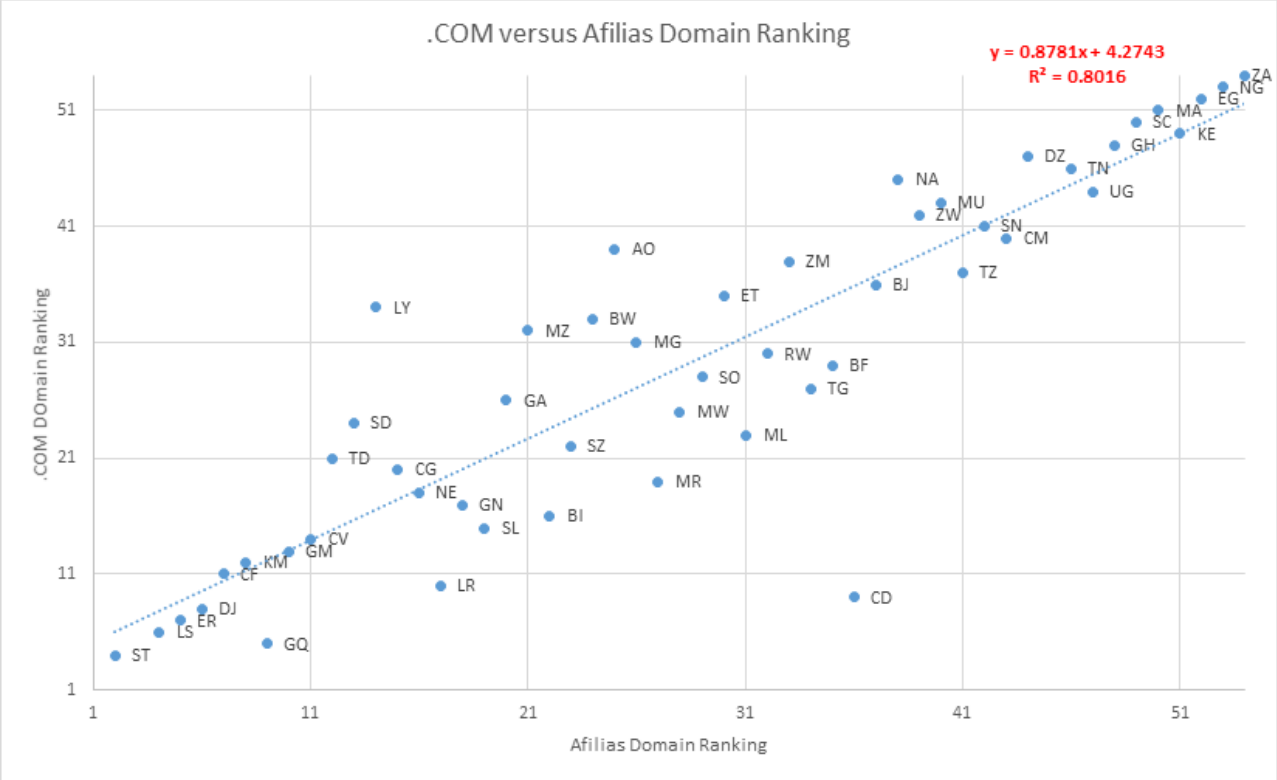
Total .COM Domains	Total Websites	% Locally Hosted Websites
South Africa	South Africa	Libya
Nigeria	Nigeria	South Africa
Egypt	Egypt	Malawi
Morocco	Morocco	Tunisia
Seychelles	Kenya	Morocco
Kenya	Ghana	Kenya
Ghana	Seychelles	Algeria
Algeria	Algeria	Tanzania
Tunisia	Tunisia	Zimbabwe
Namibia	Namibia	Gambia

This table is similar to that for the Afilias domains, with Uganda, Mali, Cameroon and Ivory Coast falling away.

5.5.5.3 gTLD Summary

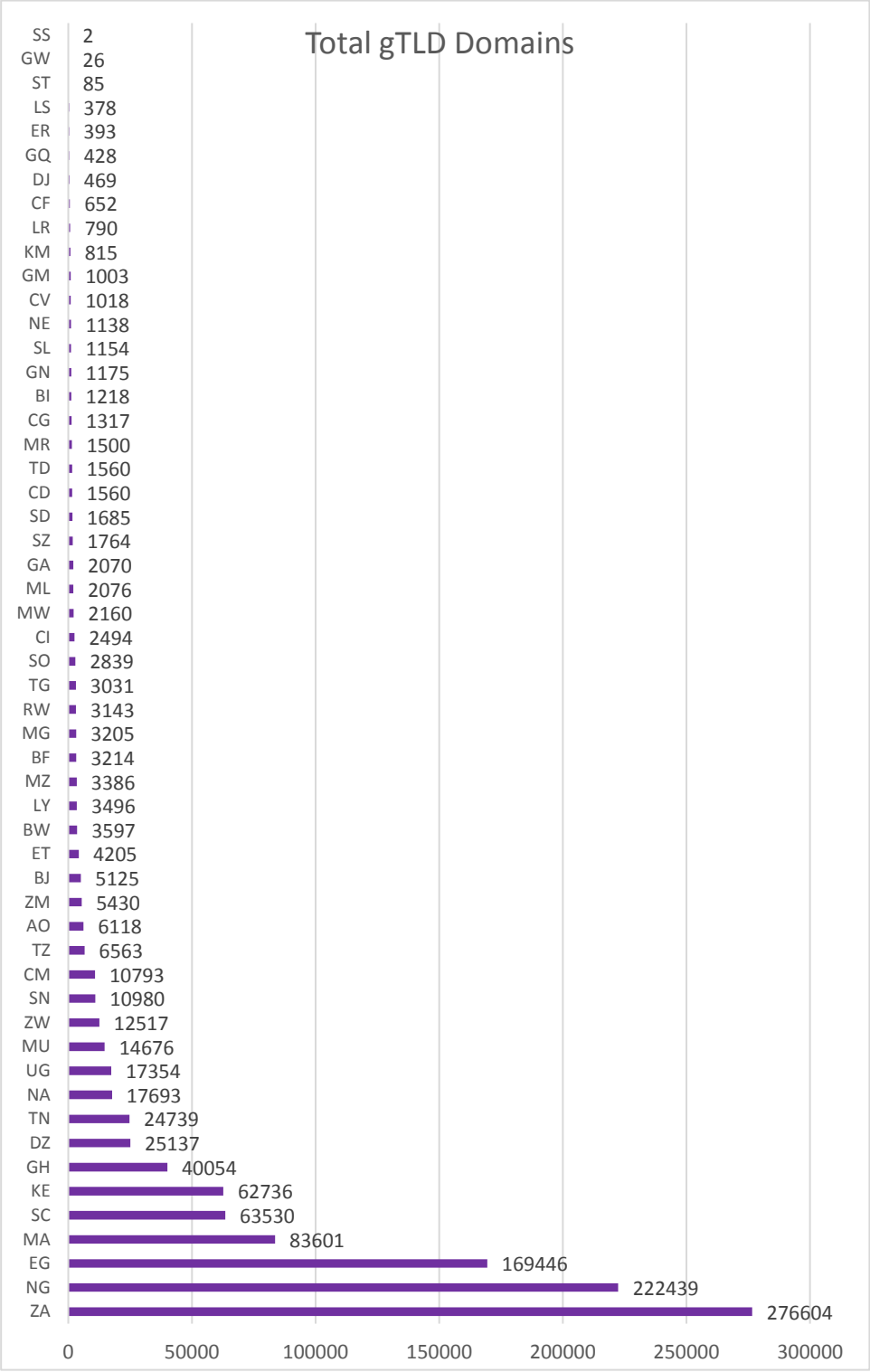
With two different sets of gTLD data, it's interesting to compare the ranking of African countries in terms of these numbers. As the graph below indicates, although there are minor changes in position at either end of the scale, a country with many Afilias gTLD domains is likely to have many .COM gTLD domains. In both cases, this indicates a more vibrant Internet ecosystem. Conversely, those countries with few Afilias gTLD domains also tend to have few .COM gTLD domains. Again, this illustrates a relatively moribund Internet ecosystem. However, there are wide variations in some cases, with the countries that fall between these two extremes.

Figure 5-52: Correlation between Afilias and .COM gTLD Domains



In contrast to the Draft Report, which ranked countries on the number of Afilias gTLD domains registered, this Final Report now ranks countries on all gTLD domains identified. See section 7.2.

Figure 5-53: Total gTLDs per Country

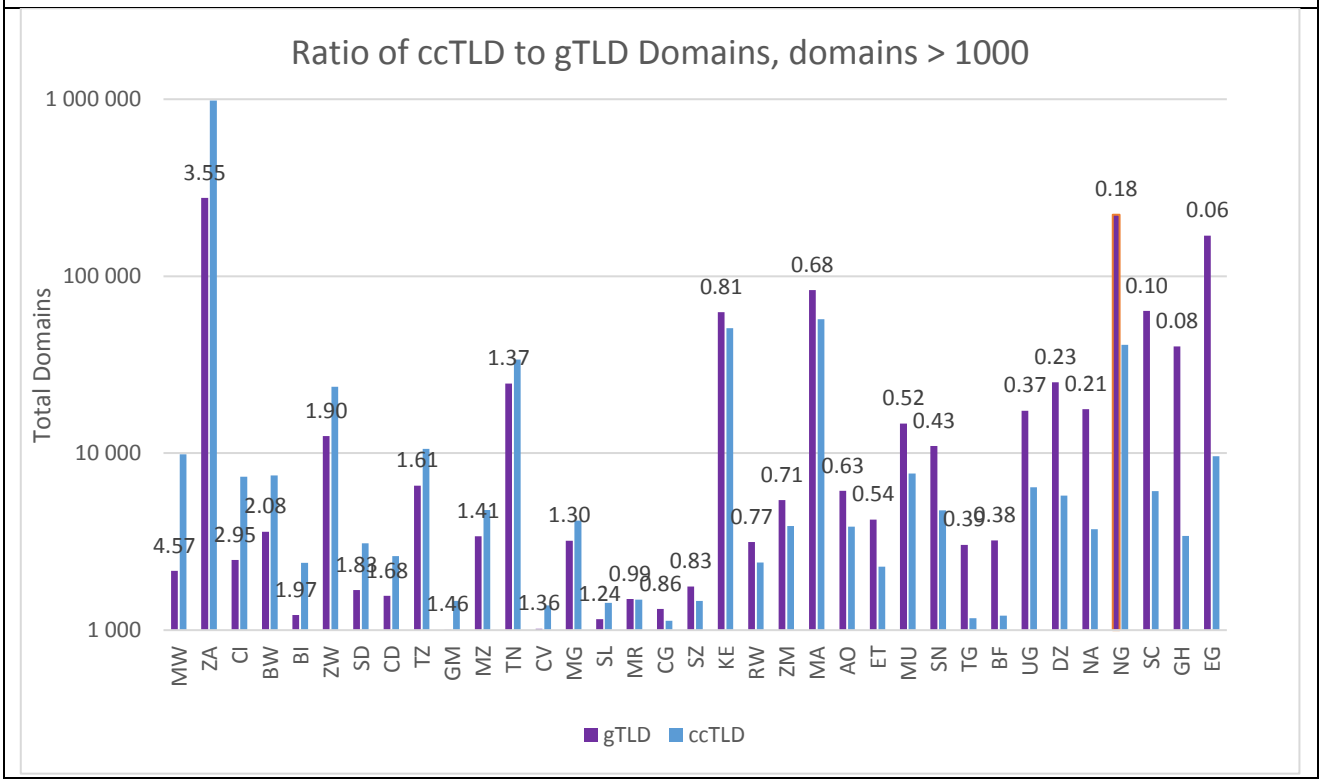


5.5.5.4 Comparison of ccTLD and gTLD domains

When we compare the number of ccTLD domains counted by DomainTools, versus the number of gTLD domains identified as associated with Africa by Afilias and EyeDomain, there are considerable differences. In the graphic below, the ratio between these two numbers of domains is shown for those countries with more than 1,000 domains in each category, and excluding the "domain hack: countries. Its value is indicated in the column labels. From the point of view of the local domain name industry, the left of the graph may be considered as "good" and the right considered as "bad".

Note that the gTLD data is as of September 2016, and the ccTLD data is as of November 2016.

Figure 5-54: Comparison of gTLD versus ccTLD domain, Excluding



5.5.5.5 African Zone Files

The complete list of Zone Files that had been made available by the time of writing is shown in the table below, although even for these four countries, we were not able to acquire all zone files.

Table 5-8: African Zone Files

ZONE	COUNT
CO.ZA	1 001 013
CO.ZW	22 794
ORG.ZA	22 203
CAPETOWN	4 407
JOBURG	3 407
DURBAN	2 459
SD	2 110
WEB.ZA	1 713
ORG.ZW	1 208
CO.LS	1 045
AC.ZW	477
GOV.SD	474
NOM.ZA	351
COM.SD	316
ORG.LS	166
EDU.SD	142
EDU.ZA	94
ORG.SD	75
NET.SD	33

In terms of where websites are hosted, the following table summarises the locations:

Table 5-9: ccTLD Hosting Locations

Country	Total Domains	Total Websites	Hosted Locally	Hosted in Africa	Hosted Overseas
LS	1 168	400	81	135	184
SD	3 153	1 082	379	3	700
ZW	24 479	7 367	1 964	511	4 892
ZA	1 025 410	504 223	358 388	118	145 717

The table above also highlights two other trends:

- Only between a third and a half of the domains have websites behind them, the remainder are inactive;
- Despite the relatively well developed hosting ecosystem in South Africa, about one third of the websites are hosted off-shore. Even Zimbabwe, which has direct fibre connections with South Africa, chooses to host most of its websites off-continent.

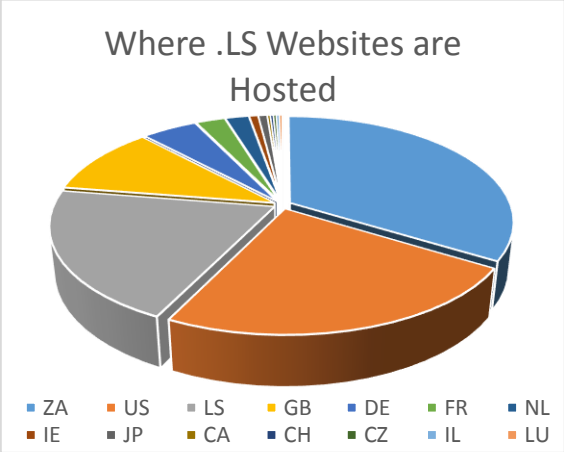
5.5.5.6 Lesotho

Lesotho had a total of 1 168 domains in the Zone Files provided. Of these, 510 had configured web servers, and 400 (34%) had websites significant content. Of these, 81 are hosted in Lesotho itself, with 135 hosted elsewhere in Africa (all of them in South Africa), leaving 184 (46%) websites hosted overseas. Although .LS websites are hosted in a total of 14 countries, being surrounded by South Africa, with its well-developed hosting infrastructure, it is not surprising that Lesotho's ccTLD has the highest percentage of both ccTLD and Afilias gTLD domains hosted by another country on the African continent - South Africa leads with 34%, followed by the US with 24% and Lesotho itself with 20%.

Table 5-10: Hosting of LS Websites

Host	Count	Percentage
ZA	135	34%
US	94	24%
LS	81	20%
GB	42	11%
DE	19	5%
FR	10	3%
NL	8	2%
IE	3	1%
JP	3	1%
CA	1	
CH	1	
CZ	1	
IL	1	
LU	1	

Figure 5-55: Hosting of LS Websites



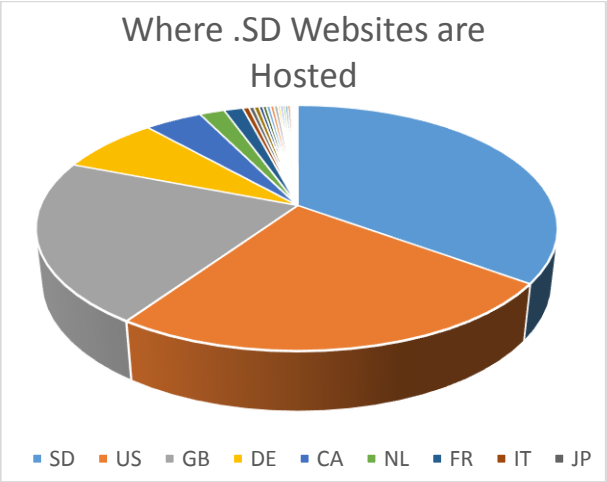
5.5.5.7 Sudan

Afilias' Zone File with entries relating to Sudan had 3 153 domains in nine zones, including one IDN. A total of 1 082 entries (34%) had functioning websites. Of these, 379 were hosted locally, three elsewhere in Africa and the balance of 700 overseas, in a total of 26 countries. The top seven of these are:

Table 5-11: Hosting of .SD Websites

Host	Count	Percentage
SD	379	35%
US	265	24%
GB	232	21%
DE	81	7%
CA	46	4%
NL	20	2%
FR	15	1%

Figure 5-56: Hosting of .SD Websites



The Sudan case provides a good example of site hosting preferences (and therefore domain registration trends) that are not strongly influenced by geographic proximity, backbone routes or colonial ties. It is noteworthy that more than one third of the websites are hosted locally, while the US and the UK are roughly equal contenders for the majority of the remaining websites. The relatively high proportion of local web hosting may be partially the result of the international boycott on Sudan, although the large number of US-based sites belies this conclusion.

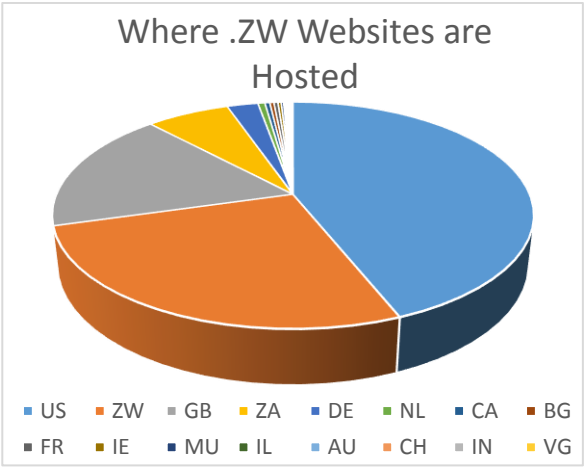
5.5.5.8 Zimbabwe

Zimbabwe has 24,479 domains in the three zones that were provided, with 7,367 (30%) having websites. Of these, 1,964 (27%) are hosted locally, 511 elsewhere in Africa (7%) and 4892 (66%) overseas. .ZW websites are hosted in a total of 29 countries. The top countries are: -

Table 5-12: Hosting of .ZW Websites

Host	Count	Percentage
US	3235	44%
ZW	1964	27%
GB	1285	17%
ZA	493	7%
DE	183	2%
NL	41	1%

Figure 5-57: Hosting of .ZW Websites



As with Sudan, the UK and the US are the top locations for off-shore web hosting which, as indicated above, is somewhat surprising given the well-developed hosting environment in South Africa, a country with which Zimbabwe also has close economic, cultural and infrastructure ties.

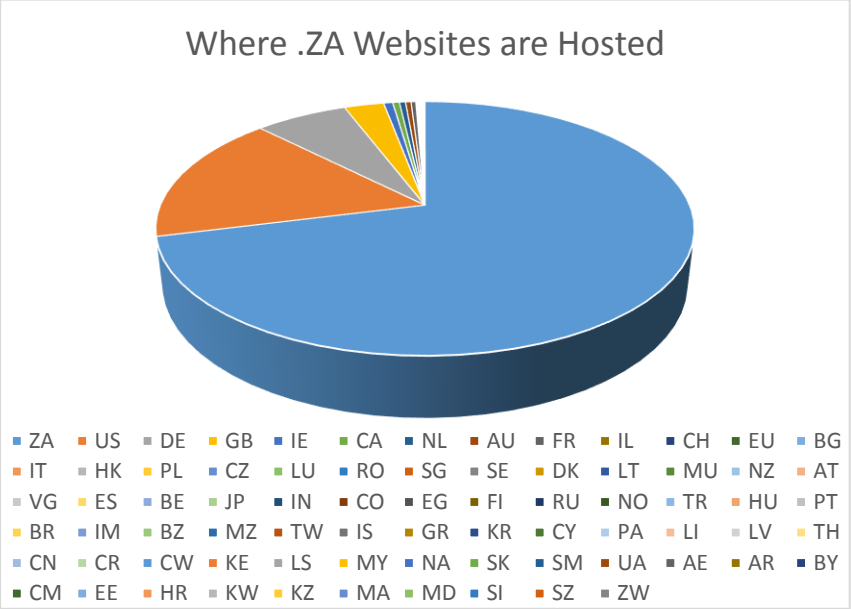
5.5.5.9 South Africa

South Africa has 1,025,410 domains in the five zones which were provided. Of these, 49% have websites and 71% of those are hosted locally. Altogether, .ZA websites are hosted in 75 countries, the most popular of which are the US, Germany and the UK (aside from a large majority of in-country hosting).

Table 5-13: Hosting of .ZA Websites

Host	Count	Percentage
ZA	358388	71%
US	83051	16%
DE	33537	7%
GB	14312	3%
IE	3279	1%

Figure 5-58: Hosting of .ZA Websites



5.5.5.10 City gTLDs: .CAPETOWN, .DURBAN & .JOBURG

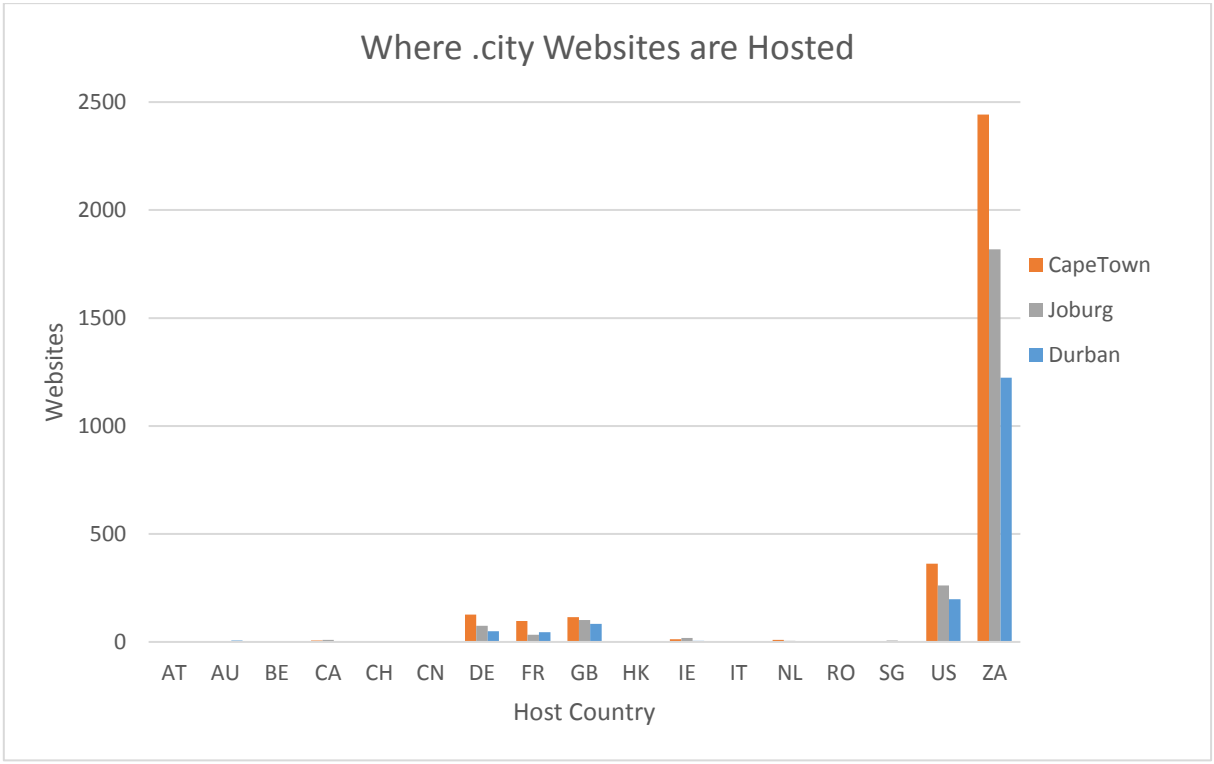
The 10 273 city gTLDs[112] have a total of 7 139 or 69% websites. This high proportion is indicative of the importance placed on these new gTLD domains. Most of the websites - 77% - are hosted in South Africa, but a total of 17 countries host pages for these domains. The top six are shown in the table below, with a graphical representation of the distribution.

[112] As of November 2016

Table 5-14: Hosting of CITY gTLDs

Host Country	.DURBAN	.CAPETOWN	.JOBURG	Totals	Percentage
ZA	1 223	2 442	1 818	5 483	77%
US	198	362	262	822	12%
GB	83	114	102	299	4%
DE	50	126	74	250	4%
FR	45	97	33	175	2%
IE	5	13	18	36	1%

Figure 5-59: Hosting of CITY gTLDs



6 KEY FEATURES OF THE AFRICAN DNS MARKET

6.1 Internet Services - Institutional Roles

6.1.1 Regional and National ICT Policy, Strategies and Regulatory Authorities

6.1.1.1 ICANN

ICANN published its five year plan for Africa starting from 2016, which aims to increase the participation of Africans and to support a stronger presence for ICANN in Africa. The strategy objectives are to strengthen ccTLD development, enhance cooperation with Computer Emergency Response Teams (CERTs) for better handling of DNS related incidents, and promote new gTLD registries.

Strategic objective is to strengthen ccTLD development

6.1.1.2 AfriNIC

AfriNIC has also contributed to ICT strategy development in Africa by developing an ICT Strategy Matrix. It highlights four areas: a) DNS stability and security; b) Core operations including IANA; c) Competition, consumer trust and consumer choice; and d) A healthy governance ecosystem.

Other ICT community initiatives have been supported by AfriNIC regarding the IPv6 transition, the establishment of CERTs, and the implementation of DNSSEC.

6.1.1.3 The African Union (AU)

The African Union Commission (AUC), based in Ethiopia and its associated NEPAD Planning and Coordinating Agency[113] based in South Africa have continent-wide ICT support strategies. Most notable are the Programme for Infrastructure Development in Africa (PIDA), cybersecurity capacity building, regional policy and regulatory frameworks, electronic postal systems, the .AFRICA gTLD and the AXIS project to support the development of IXPs.

The AU and the AUC work closely with the UN Economic Commission for Africa (UNECA), national governments and regional entities in the implementation of its programmes, which are often supported by interested donor agencies such as the European Commission.

[113] www.nepad.org

6.1.1.4 The Regional Economic Communities (RECs)

At a regional level, the African Regional Economic Communities (RECs) all have a variety of programmes to support the development of ICT infrastructure in their Member States, often in collaboration with the regional regulatory associations. For example, the Southern African Development Community (SADC) has developed a comprehensive ICT infrastructure development plan which is being supported by the Communication Regulators Association of Southern Africa (CRASA). As in other sub-regions in Africa, the SADC's plan prioritises capacity building in technology, broadband connectivity and services affordability.

SADC prioritises technology, broadband connectivity and services affordability

Similarly in West Africa, ECOWAS is in the process of developing an integrated infrastructure master plan which focuses on cross-border projects in ICT, energy, transport and water resources to support regional integration.

The other key regional bodies with ICT related programmes are: the Arab Maghreb Union (AMU/UMA), the East African Community (EAC), the Intergovernmental Authority on Development (IGAD), the Common Market for Eastern and Southern Africa (COMESA) and the Economic Community of Central African States (ECCAS).

6.1.1.5 National Policy and Regulatory Bodies

National policy and regulatory authorities are responsible for developing and implementing an enabling environment for the development of ICT services in the country. Virtually all countries in Africa have a specific body (ministry) responsible for policy development, and an independent authority responsible for regulating the ICT sector, although some of them are relatively new.[114] [115]

The strategies and capacity of these institutions vary widely across the continent – in some cases, such as Ethiopia, the government has continued to maintain a single monopoly telecom operator for all voice and Internet services. However in most countries, the retail market has been opened to multiple mobile operators while retaining one or two fixed operators. In a few cases technology and service neutral licenses have been issued, which effectively creates an open market, although there may be high license fees or other restrictions on market entry. Some countries have also created wholesale operators, either simply by licensing private providers or

[114] The Swaziland Communications Commission (SCCOM), for example, was set up by legislation in 2013, but in 2015 was still setting up its licensing framework: http://www.sccom.org.sz/ It took over from the previous combined regulator / incumbent , which it is now required to regulate: www.sptc.co.sz
[115] A fairly complete, but outdated (as far as SZ is concerned) list can be found at http://www.africantelecomsnews.com/Operators_Regulators/List_of_African_telecommunications_regulators.html

through government or Private-Public Partnerships (PPP) initiatives in creating national backbone operators (e.g. Tanzania's NICTBB) or wholesale 4G operators (e.g. Rwanda's ORN).

Regulators are usually provided with some degree of independence and financial autonomy, although the executive body of councillors is usually appointed by government. Many regulatory authorities have also taken steps to manage the country's ccTLD registry, while some ccTLD registries in Africa have no direct oversight by the regulator, as discussed further below.

Most African countries recognise the importance of ICT

The majority of African countries realise the important role of ICT in the socio-economic development of their nations, thus most governments have developed an ICT related strategic planning process which may have a broad integrated focus. Others have made sub-plans to address specific issues according to their priorities, such as a national broadband plan or a cyber security strategy.

Little research has been conducted on the scope and effectiveness of these strategies, however the ITU Broadband Commission 2016 annual report[116] includes a survey of recent ICT plans around the world. It found that 14 countries in Africa had not yet adopted this planning instrument, as shown in the table below. Given the fast pace of developments in the technologies, it is also likely that a majority of these plans will be updated in the short-to-medium term, which will provide opportunities for better inclusion of domain name management strategies for the countries concerned.

[116] http://broadbandcommission.org/Documents/reports/bb-annualreport2016.pdf

Table 6-1: ICT Plans and Strategies

Country	Year	Plan
Algeria	2008	E-Algérie 2013`
Angola	2013	White Book of Information and Communication Technologies, Information Society National Plan 2013-2017
Benin	2014	Projet de Développement des Infrastructures et des TIC
Botswana	2014	Botswana's National Broadband Strategy
Burkina Faso	2013	Réseau national de fibre optique
Cameroon	no	
Cape Verde	2005	Programme Stratégique pour la Société de l'Information (PESI) accompagné du Plan d'Action pour la Société de l'Information (PAGE)
Central African Rep.	2006	Politique Stratégies et plan d'actions de l'édification de la Société de l'Information en République Centrafricaine
Chad	2007	Plan de développement des technologies de l'Information et de la Communication au Tchad or (PLAN NICI)
Comoros	2014	Loi N° 14-031/AU du 17 Mars 2014 relative aux communications électroniques et Décret N° 08-019/PR
Congo	2011	Projet de Couverture Nationale (PCN), Projet West Africa Cable System (WACS), Projet réseau national de fibre optique
Congo (Dem. Rep.)	no	
Côte d'Ivoire	2016	Le Réseau National Haut Débit (RNHD) 2016. Objectifs Stratégiques du Gouvernement de Côte d'Ivoire en Matière de Télécommunications et de TIC 2010
Djibouti	2004	Plan d'action national pour l'exploitation des TIC en République
Egypt	2012	eMisr National Broadband Plan
Equatorial Guinea	2012	Nuevas Tecnologias: national project aimed at the popularization of technologies Information and communication (TICGE) 2012-2020
Eritrea	no	
Ethiopia	2013	National Broadband Master Plan
Gabon	2011	Digital Gabon - Gabon Industriel, Gabon vert et Gabon des Services
Gambia	2008	The Gambian ICT4D-2012 Plan
Ghana	2010	Broadband Wireless Access
Guinea	2009	Plan National de fréquences/Plan de développement de l'infrastructure nationale d'information et de communication de la République de Guinée 2001 – 2004
Guinea-Bissau	no	
Kenya	2013	National Broadband Strategy - Vision 2030
Lesotho	2014	National Broadband Policy 2014-2018
Liberia	2010	Policy for the Telecommunications and Information Communications Technology (ICT) 2010-2015
Libya	no	
Madagascar	2014	Loi n° 2005-023 du 17 octobre 2005

Country	Year	Plan
Malawi	2013	National ICT Policy
Mali	no	
Mauritania	no	
Mauritius	2012	National Broadband Policy 2012 - 2020 (NBP2012)
Morocco	2012	Plan national pour le développement du haut et très haut débit au Maroc[117]
Mozambique	2006	National ICT Policy Implementation Strategy 2002 and 2006 - Digital Inclusion in Mozambique
Namibia	2009	Telecommunications Policy for the Republic of Namibia
Niger	2005	Plan de développement des Technologies de l'Information et de la Communication au Niger / Plan NICI du Niger
Nigeria	2013	National Broadband Plan 2013-2018
Rwanda	2006	Regional Connectivity Infrastructure Program (RCIP)
S. Tomé & Principe	no	
Senegal	no	
Seychelles	no	
Sierra Leone	no data	
Somalia	no	
South Africa	2013	National Broadband Policy and National Integrated ICT Policy
South Sudan	no	
Sudan	2012	Sudan's National Strategic Development Plan 2012-2016
Swaziland	no	
Tanzania	2004	National Information Communication and Technology Broadband Backbone (NICTBB)
Togo	planning	
Tunisia	2015	Tunisie Digitale 2018
Uganda	2009	Uganda Broadband Infrastructure Strategy National Position Paper
Zambia	2006	National Information and Communication Technology Policy
Zimbabwe	2005	National ICT Policy

6.1.2 DNS Governance

As indicated above, the role of the national ICT regulatory authorities may go beyond basic infrastructure and include management of their ccTLD registries. In these cases the value of a country domain has been recognised by government as providing greater flexibility in Internet naming and supporting aspirations for ensuring the data sovereignty of the country.

According to the Zone File analysis as part of this study, domains under the ccTLDs represent the majority of registered domains in Africa and the survey shows that Regulators are responsible for

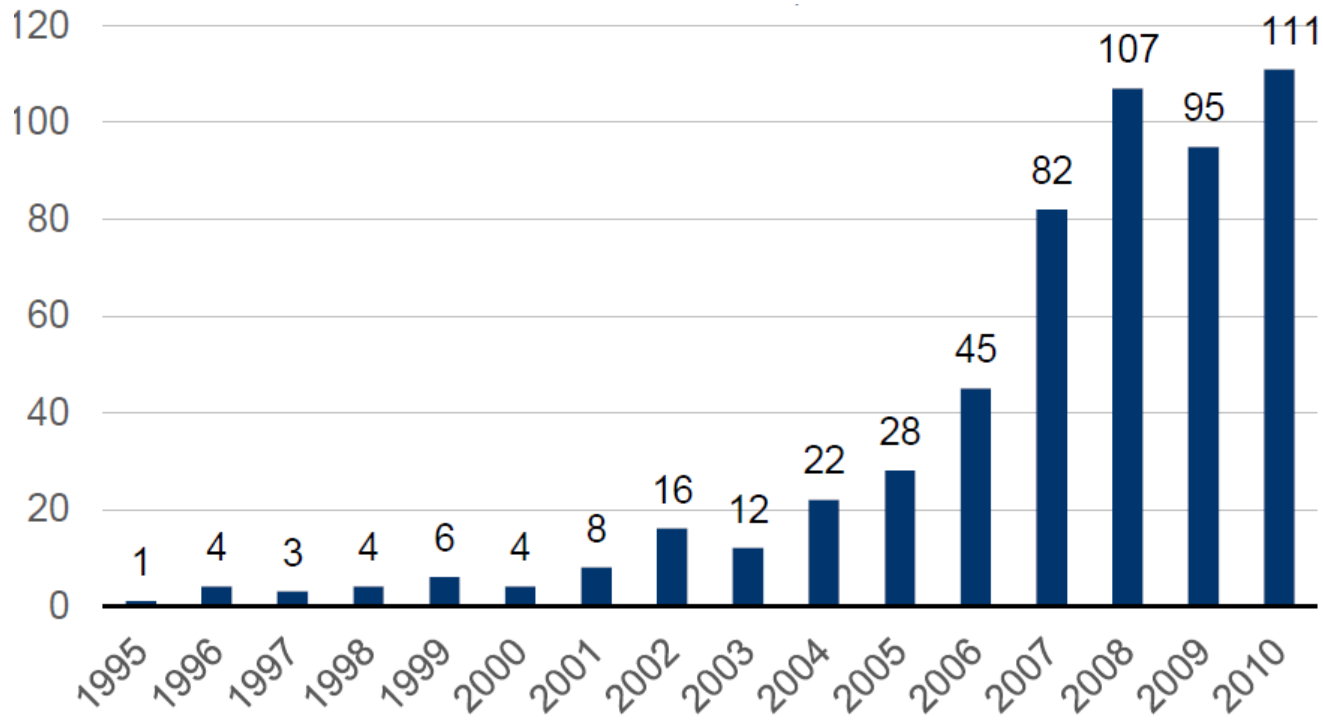
[117] See also http://www.egov.ma/sites/default/files/Maroc%20Numeric%202013.pdf

managing about 40% of ccTLDs. Examples of others include Sudan (.SD), which is managed by an NGO established in 2001 to manage the country domain. Also the ccTLD of Egypt (.EG) was delegated to the Egyptian Research and Education Network (EUN) an intergovernmental agency providing ICT services to academia. In South Africa, there is a special regulator solely for domain names, the ZA Domain Name Authority (zaDNA[118]). However, the ccTLD and many other 2LD domains are managed by the ZA Central Registry (ZACR), a private non-profit entity that manages the registries under contract.

6.1.3 The Influence of Politics on Telecommunications and the Internet

There is an increasing trend for some governments to deliberately disrupt the Internet within their countries at times, despite the high economic costs that result. The Brookings Institute[119] gives these figures for the number of Internet disruptions globally.

Figure 6-1: Internet Disruptions



The disruptions shown in the table below represent an economic cost to the African countries involved of USD $428 million in 2015 – 2016. Out of 81 instances of Internet disruptions worldwide, Africa was responsible for nine disruptions during the period 2015 – 2016.

[118] http://www.zadna.org.za/
[119] https://www.brookings.edu/wp-content/uploads/2016/10/intenet-shutdowns-v-3.pdf

Table 6-2: Internet Disruptions 2015-2016

Country	Disruptions	Cost USD $millions
Morocco	1	320.5
Congo	2	72.5
Algeria	1	20.5
Ethiopia	1	8.5
Chad	1	3.7
Uganda	2	2.2
Libya	1	0.4
Total Cost to Africa		428.3

Note that the largest of the figures in the table above, for Morocco, refers to a limited shutdown, where operators were instructed by the Regulator, ANRT, to block VoIP such as is used by common applications, like Skype, WhatsApp and Viber during most of 2016[120]. Despite the limited scope of this shutdown, the estimated cost was very high. It's also informative that the recent (2017) disruption of access to the Internet for portions of the (primarily English speaking) regions of Cameroon for 93 days[121], resulted in a drop in the number of .CM ccTLD domains recorded by DomainTools from 63,023 to 31,801 - a decline of more than 50%.

It would appear that there is a positive correlation between how democratic a country is, and how well developed its Internet infrastructure is. This can be seen with some of the African countries with particularly low numbers of domain names.

The following figures suggest a relationship between political freedom as determined by Freedom House[122] and domain names[123]

Table 6-3: Political Freedom versus Domain Names

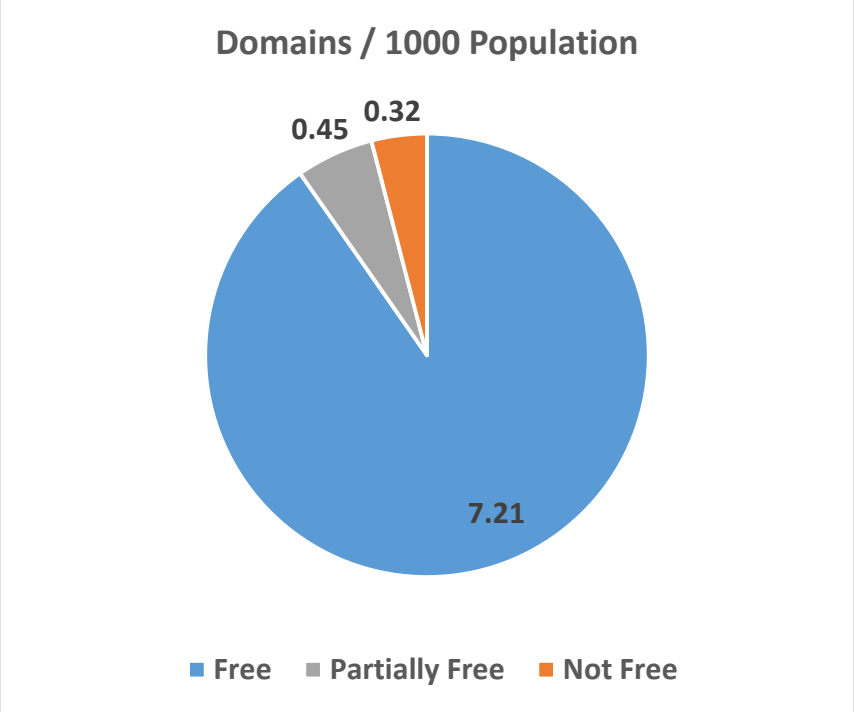
Status	Total ccTLD Domains	Domains excl. Freenom	Number of Countries	Domains / Country	Domains / 1000 Population
Free	1065220	1065220	11	96838	7.21
Partially Free	453609	219316	21	10443	0.45
Not Free	1390760	137671	21	6555	0.32
TOTALS	**2909589**	**1422207**	**53**		

[120] https://www.brookings.edu/blog/techtank/2016/10/25/morocco-reverses-app-ban-after-internet-shutdowns-report/
[121] http://www.bbc.com/news/world-africa-39665244
[122] Political data from Freedom House 2016 report retrieved from https://freedomhouse.org/sites/default/files/FH_FITW_Report_2016.pdf
[123] In all cases, the DRC is excluded, as it isn't ranked by Freedom House, and the domains from the four Freenom countries are also excluded, as they distort the results significantly.

The graphic below is particularly telling. Citizens of "Free" countries register 22 times as many domains as citizens of "Not Free" countries.[124]

There seems to be a link between democracy and Internet development

Figure 6-2: Political Freedom versus Domain Names



6.2 The ccTLD Address Space in Africa

The African continent top level DNS address space consists of 54 top level country code ccTLDs, plus five IDNs: Egypt (مصر), Algeria (الجزائر), Tunisia (تونس), Sudan (سودان) and Morocco (المغرب) as well as three city codes (.CAPETOWN, .DURBAN and .JOBURG). Western Sahara is a disputed territory, and as such it has no ccTLD, although (EH) is reserved for this purpose. Currently IANA has no sponsoring organisations assigned to this domain.

Although not covered by this study, there are some other ccTLDs that are geographically associated with Africa, but do not relate to an independent African country. These are:

- .IO - (British Indian Ocean Territory - the Chagos Islands, a protectorate of the United Kingdom in which the military base on the island of Diego Garcia is located),
- .RE (Reunion - a territory of France),

[124] This study has not examined whether there is a causal relationship between these numbers.

- .SH (Saint Helena, Ascension and Tristan da Cunha - another British protectorate).

In addition, the .AFRICA domain, which has been in planning for some time, has recently gone live.

Research data[125] from November 2016 indicates that a total of just over 2.9 million domains are active under the African ccTLDs. There are also many registrations in the gTLDs by African entities. Some of these from the Afilias database extract are analysed in section 5.5.5.1 and others from EyeDomain in section 5.5.5.2

6.3 The Demand for African Domain Names

As is evident from the above discussion, the overall use of domain names in Africa is relatively small. Personal domain name registration in Africa is relatively insignificant due to the low Internet uptake and income levels relative to the costs of overseas hosting, which must often be paid for in foreign currency with a credit card, to which local citizens may not have access. Even in those countries with a more vibrant local hosting industry, the incidence of personal domain names is relatively low.

The local business market and consequent demand for DNS registrations is constrained by a wide range of factors ranging from the high cost of setting up a business, to the lack of local hosting infrastructure. These and many other factors can be seen as part of an 'ecosystem' in which each component of the value chain needs to be in place for the market to function efficiently, which in turn creates demand for local domains.

In general it can be observed that there are two quite different markets for Africa's domain names – local/African entities and offshore (out of continent) entities, each with their own characteristics.

6.3.1 Local Entities

As indicated in Section 5, domain name registration by African entities mainly takes place in countries where the local hosting industry and web development sector has developed sufficiently to create demand for local domains. These are concentrated in a few countries where many competing networks have access to cost effective international and national backbones. This primarily comprises South Africa, Egypt, Mauritius, Nigeria, Kenya, Zimbabwe, Uganda, Tunisia and Morocco. In addition, the presence of one or more IXPs in the country makes local hosting more viable, which in turn drives up the demand for domain names. Local domain name business

[125] http://research.domaintools.com/statistics/tld-counts/

also consists of the relatively high number of registrations by African entities of domains under the legacy gTLDs due to their 'intrinsic default' attraction, as well as effective marketing and efficient / cost effective service provision, and lack of reliable (perceived or real) and affordable local domain registration and hosting options within Africa.

6.3.2 Offshore Entities

Many African ccTLD sub-domains are registered by entities located outside Africa, usually because the special characteristics of the domain results in demand from special interest groups which may be present in other parts of the world, or because multi-national businesses have registered domains under the ccTLDs as a strategy for securing their intellectual property interests.

In a small number of cases domains have been registered by diaspora Africans, however the vast majority of off-shore registrations are concentrated in the countries with ccTLDs that are amenable to 'domain hacks', often using a ccTLD as part of a word, as described below.

6.3.3 Domain Hacks

A surprisingly large number of African countries have high numbers of domain registrations because these countries charge little to register a domain, or the particular letters of the ccTLD are attractive for special purposes with more relevance than registration in the gTLDs such as .COM or .NET. In addition these countries have non-restrictive rules that allow registration of domains from entities located outside the country. These practices are known as 'domain hacks', and in Africa, the 11 most popular of these are:

- Central African Republic (.CF) - This domain is one of the 'suite' of free African ccTLDs, along with .GQ, .GA and .ML, which were developed as free domains by registrars Freenom[126] and Safecow[127]. These domains are free to register and some are for use by both individuals and corporations, while others are only available to companies. The domains need to point to a working site with real content (no 'under construction' sign) while the registrars' revenue models involve monetising the traffic from abandoned domains - domains that are no longer used by the registrant or are expired. The registrars continue to maintain these domains, and sell the residual traffic to advertisers. The registrars also generate revenue by upselling customers to paid domains or other services (such as hosting or SSL certificates). Safecow is based in Algeria and South Africa, while Netherlands-based Freenom has an office in Dakar, Senegal. The poor return from this ccTLD is illustrated by Google indexing only 2 million

[126] http://www.freenom.com/en/freeandpaiddomains.html
[127] http://www.safecow.com/free-hosting.php

pages, or 4 pages per domain. Compare this with the average for Africa of 555 pages per domain.

- Cameroon (.CM) - a domain that has been sold internationally for many years for use mainly by advertising sites aiming to take advantage of user errors when typing the .COM gTLD, or the .CN ccTLD for China. It is also used by organisations, such as the CyanogenMod project which uses http://get.cm as an easily remembered shortened URL for distributing versions of its software. Google indexes 3 million pages, or 45 pages per domain.
- Djibouti (.DJ) - is marketed by a large number of commercial registrars for use by music-related sites due to the common use of "DJ" to mean disc jockey. A project was also under development to use it for "Data Journals", however this has not proven popular. Google indexes 2 million pages, or a reasonable 283 pages per domain.
- Equatorial Guinea (.GQ) - a domain that is free to register, operated in the same way as .CF, .GA and .ML by registrars Freenom and SafeCow (see above). Google indexes 3.5 million pages, or a very low 13 pages per domain.
- Gabon (.GA) - Similar to .GQ, .ML and .CF, Gabon's ccTLD is available as a free domain by Freenom and SafeCow (see above), but can only be registered by corporations, not by individuals. Google indexes 2.3 million pages, or a very low 5 pages per domain
- Libya (.LY) - Many Libyan domains have been used for words that end with the suffix "ly", such as name.ly, sil.ly and sincere.ly. Popular URL shortening services are registered in the .LY domain, such as: brief.ly, adf.ly, bit.ly (former default for Twitter), ow.ly (default for Hootsuite), and 3.ly. The annual fee for .LY domains is USD $75 a year so many domain names remain available on the premium domain market, and some popular domains can be bought on the secondary domain market from domain name speculators. Google indexes 12 million pages, or a high 979 pages per domain. This indicates that the .LY ccTLD is actually being used for viable content.
- Mali (.ML) - Similar to .GQ, .GA and .CF, Mali's ccTLD is a free domain marketed by Freenom and Safecow (see above). Although it was the first African country to give its domain away for free, it can only be registered by companies (legal entities). In comparison to the others, relatively few offshore web pages are hosted under the .ML domain, which has gained a reputation for fraudulent use by the 'phishing' industry. Google indexes 0.5 million pages, or an extremely low 2 pages per domain.
- Mauritius (.MU) - while most domains registered under this domain are domestic, this is not a requirement, and some registrars market it for use in the music industry, and as a shorter alternative to the .museum TLD. Google indexes 7.4 million pages, or a high 963 pages per domain.

- Seychelles (.SC) - is registered by many of the large number of off-shore companies that are registered in the Seychelles due to its popularity as an international business location. It is also marketed by many registrars for use by entities in Scotland and the US state of South Carolina. Google indexes 5.5 million pages, or a high 895 pages per domain.
- Sao Tome et Principe (.ST) - marketed by many registrars as a domain for applications such the abbreviation of "street", short for "Star Trek", and to create domain names that spell words ending in "st". In addition the Washington Post uses .ST as part of their URL shortening domain, wapo.st, and it is also used by people of the state of Styria, in Austria, and the Swedish city of Stockholm. Google indexes 4.3 million pages, or 345 pages per domain.
- Somalia (.SO) - a relatively large number of international websites such as phy.so, comics.so and retire.so use the Somalia ccTLD as a domain hack for creating memorable domain names. Google indexes 3 million pages, or a low 206 pages per domain.

6.3.4 Local Presence and Other Requirements

Most of the African ccTLDs are available for registration for offshore entities without the requirement for a local presence. In a few countries corporate registrants are required to provide evidence such as a copy of business registration, tax identification document or a trademark matching the domain name, and may occasionally be required to provide a copy of a passport. Many offshore registrars offer 'trustee services' to get around requirements for local presence in some countries.

A total of 15 countries in Africa require some form of local legal presence (corporate or individual) to register a domain name: Algeria, Angola, Benin, Burkina Faso, Cap Verde, Egypt, Gambia, Guinea, Liberia, Mauritania, Niger, Senegal, Tanzania, Tunisia and Zambia. With the exception of Angola, Tanzania and Zambia, these countries can be seen to be predominantly concentrated in West and North Africa and are mostly French speaking.

6.4 African DNS Fee Structures

In terms of fees charged for domain registration, for comparative purposes, the chart below lists the lowest fees found charged by registrars for domains in African ccTLDs, for which the average fee across Africa is about USD $84 per annum. As can be seen from the chart below, only 19 countries have annual fees of USD $50 or less and five countries have annual fees of over USD $200 (Chad, Lesotho, Rwanda, Niger and Congo). Prices are often lower for in-country registration, however, the international price was used to provide a

Only 19 countries have annual fees of $50 or less

uniform basis for comparison. Two countries are not available for domain registration by international registrars: Comoros and Eritrea.

International fees are typically about 70% higher than local fees, as shown by the comparison below.

Figure 6-3: Comparison of Local and International Domain Registration Prices

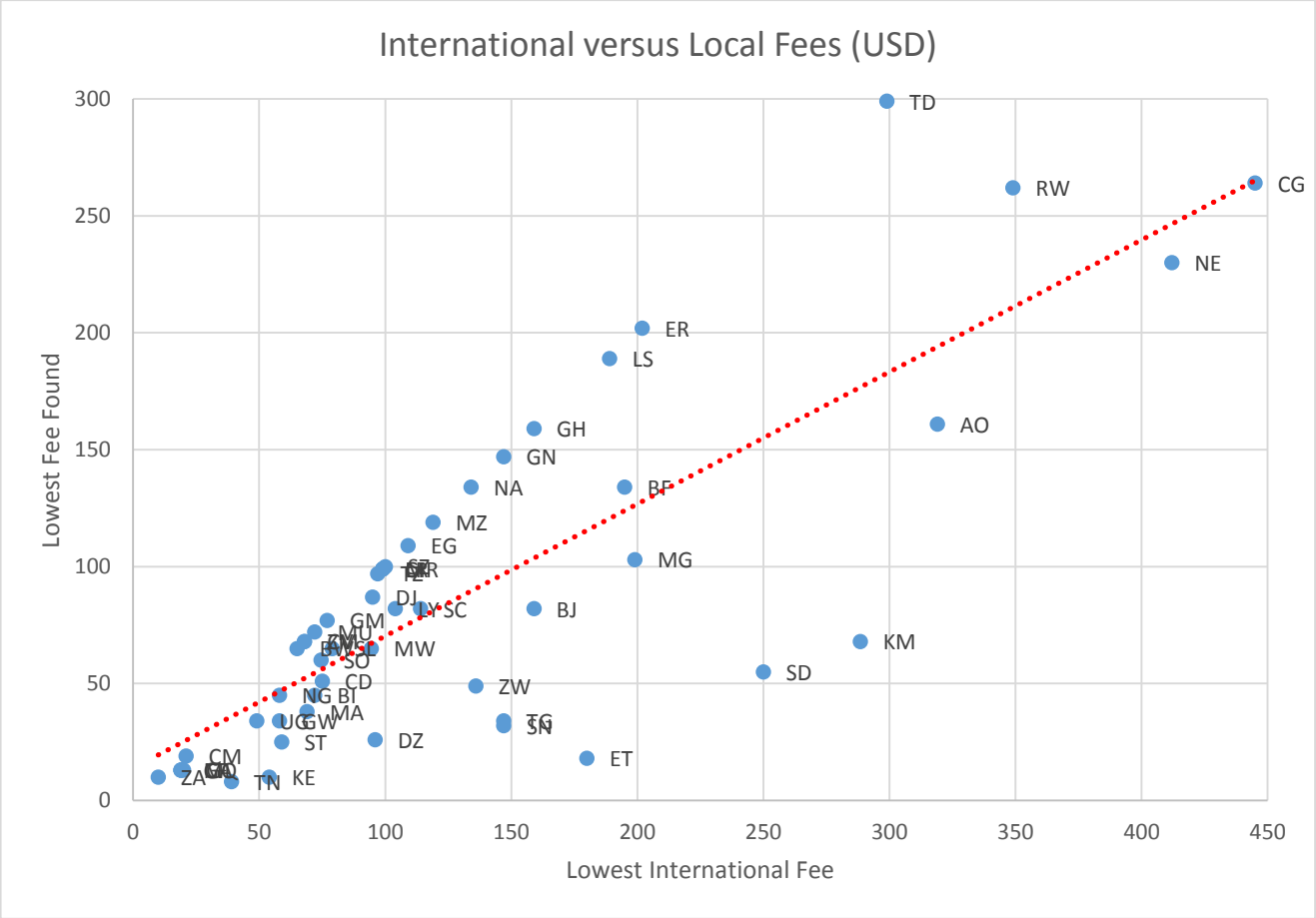
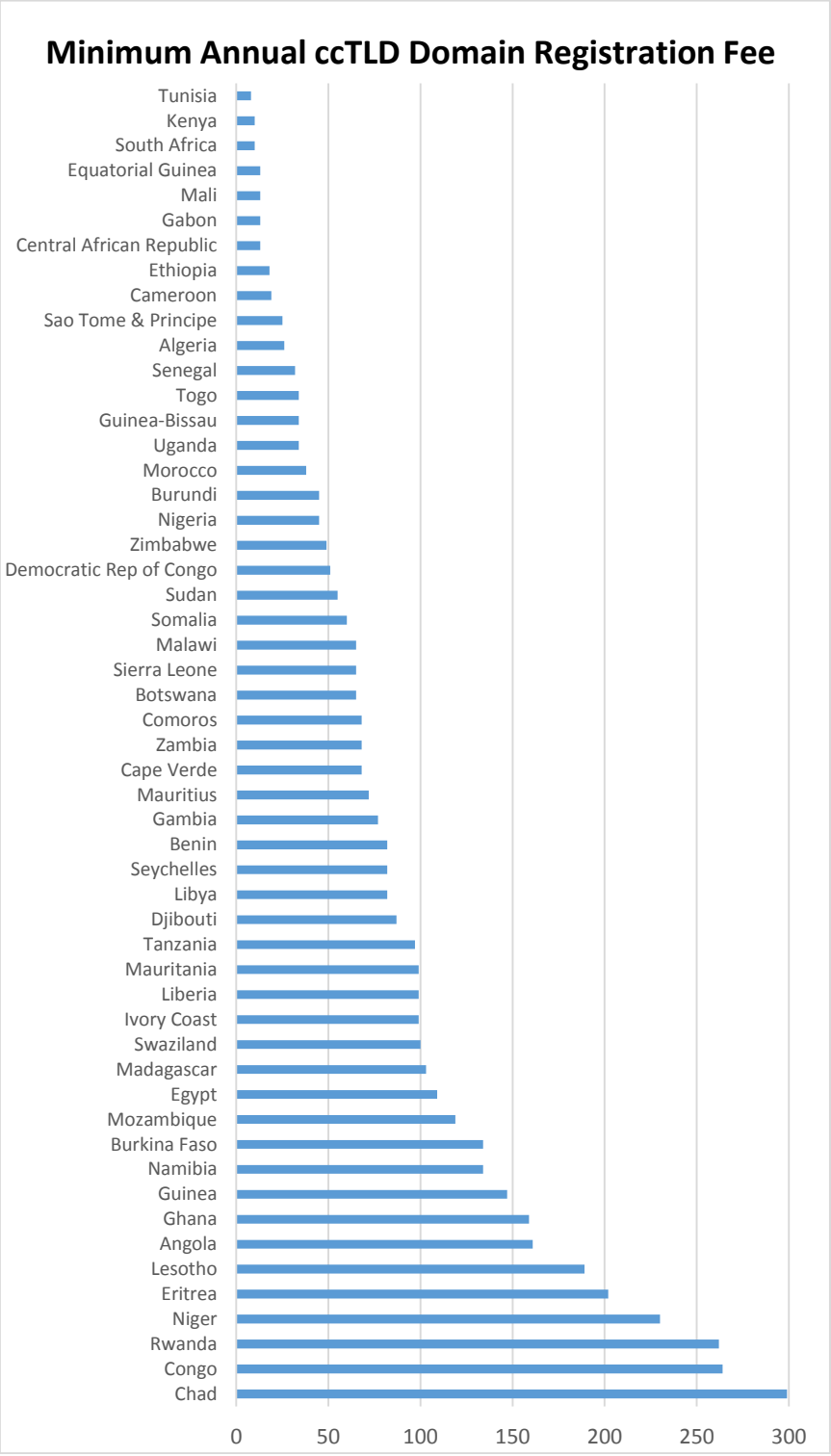


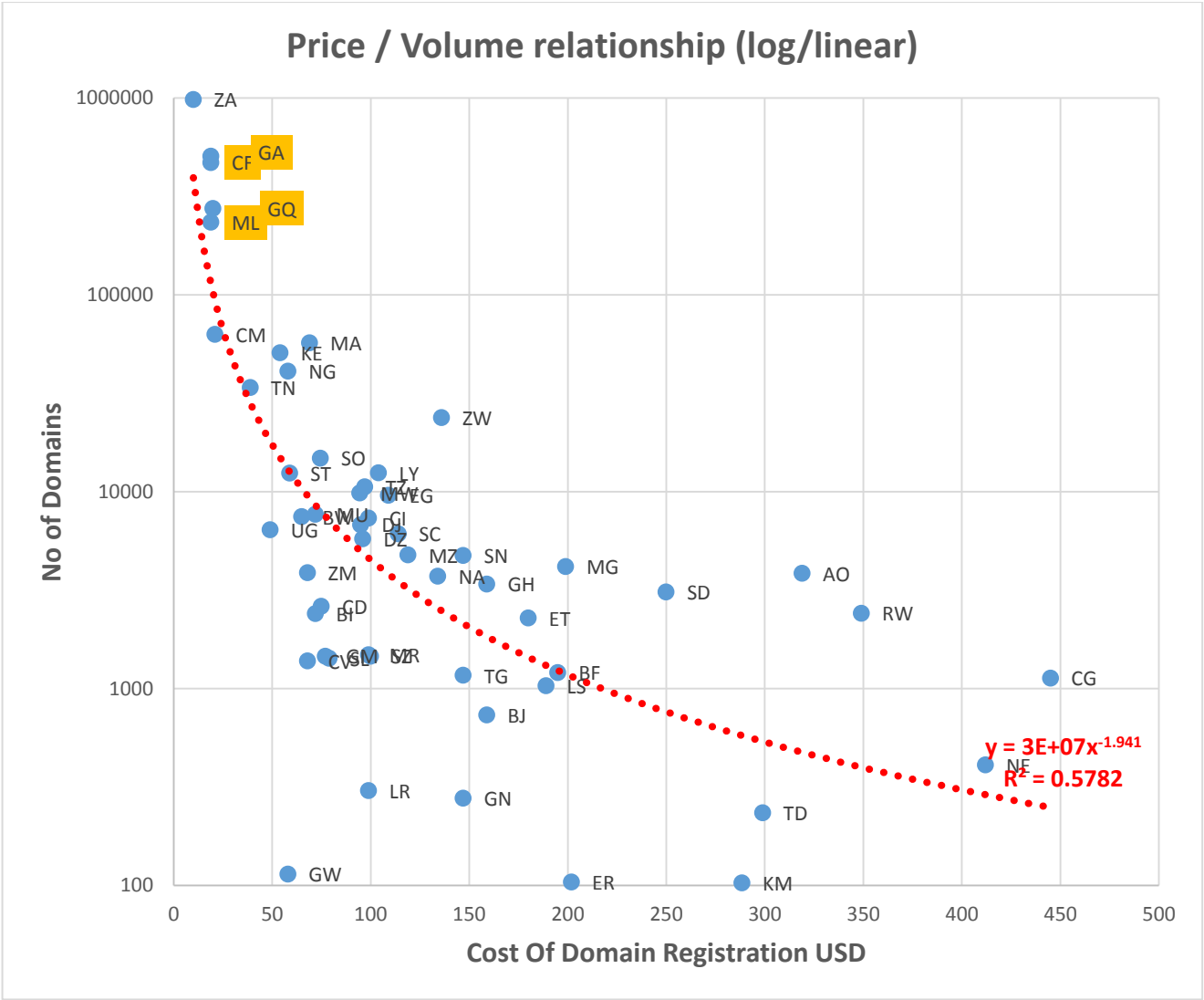
Figure 6-4: Cost of Registering a Domain via an International Registrar



The chart below plots the price of domains against the number of domains registered, which shows a clear relationship - low prices usually mean high volumes, while high prices mean low

volumes. The four Freenom countries are highlighted in orange. As would be expected there are a number of ccTLDs that do not conform to the relationship trend between price and number of registrations. Apart from the variations in size of population, and levels of Internet uptake and development of broadband infrastructure, the other reasons for this are analysed further below.

Figure 6-5: Domains Registered versus Price



Note that Guinea-Bissau (GW), Eritrea (ER) and the Comoros (KM) have around 100 domains each, while Liberia (LR), Guinea (GN) and Chad (TD) have about 300 domains each. The reasons for these very low numbers are examined in section 7.4, together with a few other underperforming ccTLDs. As is to be expected, price is by no means the only factor determining domain name sales, and therefore the coefficient of determination (denoted by R^2) is only moderate at 58%.

6.4.1 Why are free domains not good?

Why is it not a good idea to have free domains? In the real world, nothing is free. The model used by Freenom and others is that the Registrant has no rights to the domain. If the website attracts significant traffic – or insufficient traffic, it may be removed from the control of the original Registrant without any notice or compensation, and his content replaced with advertising. This is the "Freemium: business model, and is clearly stated in the terms & conditions of contract. Secondly, free domains attract the underworld – phishing scams and the like[128]. Thirdly, because of their poor reputation, it's very hard to achieve a good ranking with Google and other search engines for a website on a free domain. Fourthly, Registrars such as Freenom add an additional revenue stream by offering website and email hosting. This means that this source of revenue – and its concomitant growth of data centres and the skills required to build, manage and maintain data centres, servers and websites – is enjoyed overseas, and not in Africa.

It is thus far preferable to charge a small but real fee for registration and renewal of a domain name. This can be as low as $2 per annum, but gives the Registrant real rights in exchange for his money and ensures that he keeps his contact details with the Registry updated. In addition, it considerably increases the likelihood that ccTLD's country will gain secondary economic benefits from the registration.

Domain prices should be set at no more than a cost recovery level, in order to maximise economic benefit to the country as a whole.

6.5 Valuation of the African DNS Industry

To derive a rough indication of the total value of the domain name sector in Africa, the total number of domains registered in each country can be multiplied by the indicative registration fee[129]. This does not take into account premium domain revenues, or the small number of domains that may be provided for free (such as under .AC.ccTLD in some countries), nor those sub-domains which are not free even under the Freenom model[130]. Nevertheless, this calculation provides a general indication of the value of the ccTLD domain industry on the continent – about USD $38 million per year. At least 25% of this is likely to accrue to the international registrars and the remaining $29 million would be either local revenue or capital inflow generated by the ccTLDs and Registrars. It is also possible that up to $14 million a year is paid by African entities

[128] https://www.netnames.com/insights/blog/2013/10/are-free-domains-really-a-good-idea/
[129] The fee calculated includes either the initial registration fee or annual renewal, as well as the DNS hosting for a year but not web hosting.
[130] Freenom sells Premium Domain Names at a premium.

to foreign registrars for domains under the gTLDs[131]. This gives a total valuation of the domain name industry in Africa of some USD $52 million.

About 73% of the total annual ccTLD revenue on the continent is made by just ten countries, as shown in the table below.

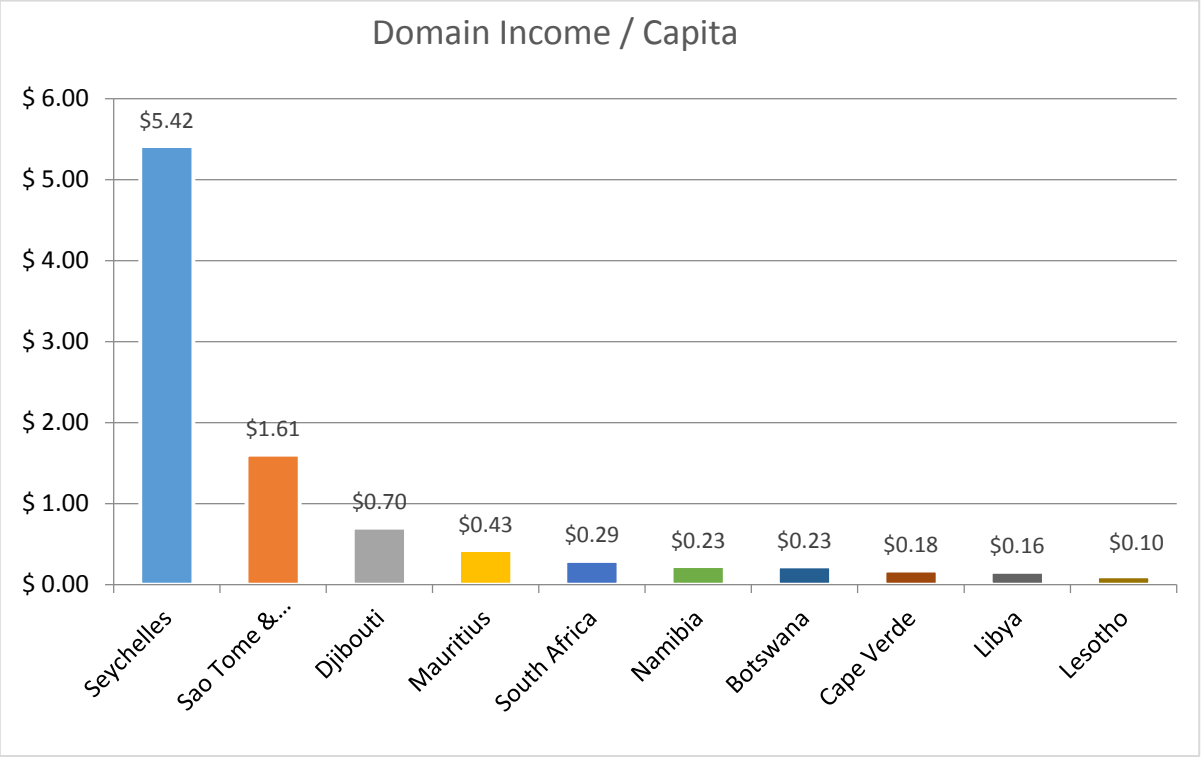
Table 6-4: Annual ccTLD Revenue

Country	Minimum Fee	Annual DNS Revenue	% of Total
South Africa	$10	$16 043 410	43%
Morocco	$38	$2 171 358	6%
Nigeria	$45	$2 031 300	5%
Zimbabwe	$49	$1 131 165	3%
Egypt	$109	$1 055 338	3%
Tanzania	$97	$1 054 875	3%
Libya	$82	$1 027 132	3%
Somalia	$60	$867 420	2%
Cameroon	$19	$849 148	2%
Ivory Coast	$99	$758 835	2%

Looking at the income earned from domain names per capita, the Seychelles earns USD $5.42 per head, followed by Sao Tome & Principe, Djibouti and Mauritius. All of these are "domain hack" countries. South Africa follows with USD $0.29. The top 10 per capita DNS industry earning countries are shown in the chart below.

[131] Based on 1 million .com/.net/org domains @ USD 10/year

Figure 6-6: Domain Income per capita



6.6 Registration Services

Compared to other regions, Africa has a very small number of registrars. In total, there are only 11 ICANN accredited registrars in Africa[132] - four in South Africa, two in Morocco and one each in Burundi, Ghana, Nigeria, Senegal and Tunisia:

1. AFRIREGISTER S.A. – Burundi;
2. Arcanes Technologies – Morocco;
3. ATI – Tunisia;
4. Diamatrix C.C. - South Africa;
5. Domain Name Services (Pty) Ltd - South Africa;
6. Genious Communications SARL/AU – Morocco;
7. Ghana Dot Com Ltd – Ghana;
8. Internet Solutions (Pty) Ltd. South Africa;
9. Kheweul.com SA – Senegal;
10. Upperlink Limited – Nigeria; and
11. Web4Africa Inc. - South Africa.

Only 11 ICANN accredited Registrars are from Africa

[132] https://www.icann.org/registrar-reports/accredited-list.html & https://www.internic.net/alpha.html

These 11 are a tiny proportion (0.5%) of the total 2,143 ICANN accredited Registrars, of which 1653 or 77% are from the USA.

Research gathered directly for this report identified 1490 Registrars, including off-shore Registrars that are taking registrations for African ccTLDs. There is significant duplication in this number, with some organisations whose primary business is acting as a Registrar selling domains for several dozen African ccTLDs. There are also a number of African Registrars who are accredited by or resellers for multiple African ccTLDs.[133]

Table 6-5: Registrars Accredited by African Registries

Country	**Registrars**	**Total Domains**
South Africa	450	982 520
Kenya	144	50 867
Mauritius	96	7 677
Madagascar	93	4 165
Sudan	80	3 091
Namibia	61	3 721
Gambia	60	1462
Nigeria	57	40 997
Tanzania	54	10 582
Somalia	52	14 827
Cameroon	51	63 023
Zimbabwe	36	23 770
Democratic Rep of Congo	35	2 619
Morocco	35	57 137
Rwanda	30	2 412
Algeria	24	5 768
Botswana	20	7 474
Ethiopia	20	2 282
Tunisia	20	33 791
Burundi	19	2 401
Mozambique	10	4 773
Egypt	4	9 607
Lesotho	3	1 035
Seychelles	3	6 110
Swaziland	3	1 462
Congo	2	1 131
Ghana	2	3 400
Angola	1	3 847

[133] This is additional work that could usefully be carried out in future.

Country	Registrars	Total Domains
Benin	1	734
Burkina Faso	1	1 206
Cap Verde	1	1 380
Central African Republic	1	470 431
Chad	1	234
Comoros	1	103
Djibouti	1	6 793
Equatorial Guinea	1	275 269
Eritrea	1	104
Gabon	1	507 389
Guinea	1	277
Guinea-Bissau	1	114
Ivory Coast	1	7 353
Liberia	1	303
Libya	1	12 464
Malawi	1	9 862
Mali	1	234 293
Mauritania	1	1 484
Niger	1	409
Sao Tome & Principe	1	12 421
Senegal	1	4749
Sierra Leone	1	1427
Togo	1	1167
Uganda	1	6410
Zambia	1	3881
Southern Sudan		n/a

South Africa has the largest number of ccTLD Accredited Registrars[134] at 450, followed by Kenya at 144, Mauritius at 96 and Madagascar at 93. On the other hand, there are 26 ccTLDs with only one Registrar each, usually the Registry itself. By definition, these ccTLDs are using the "2R" Model.

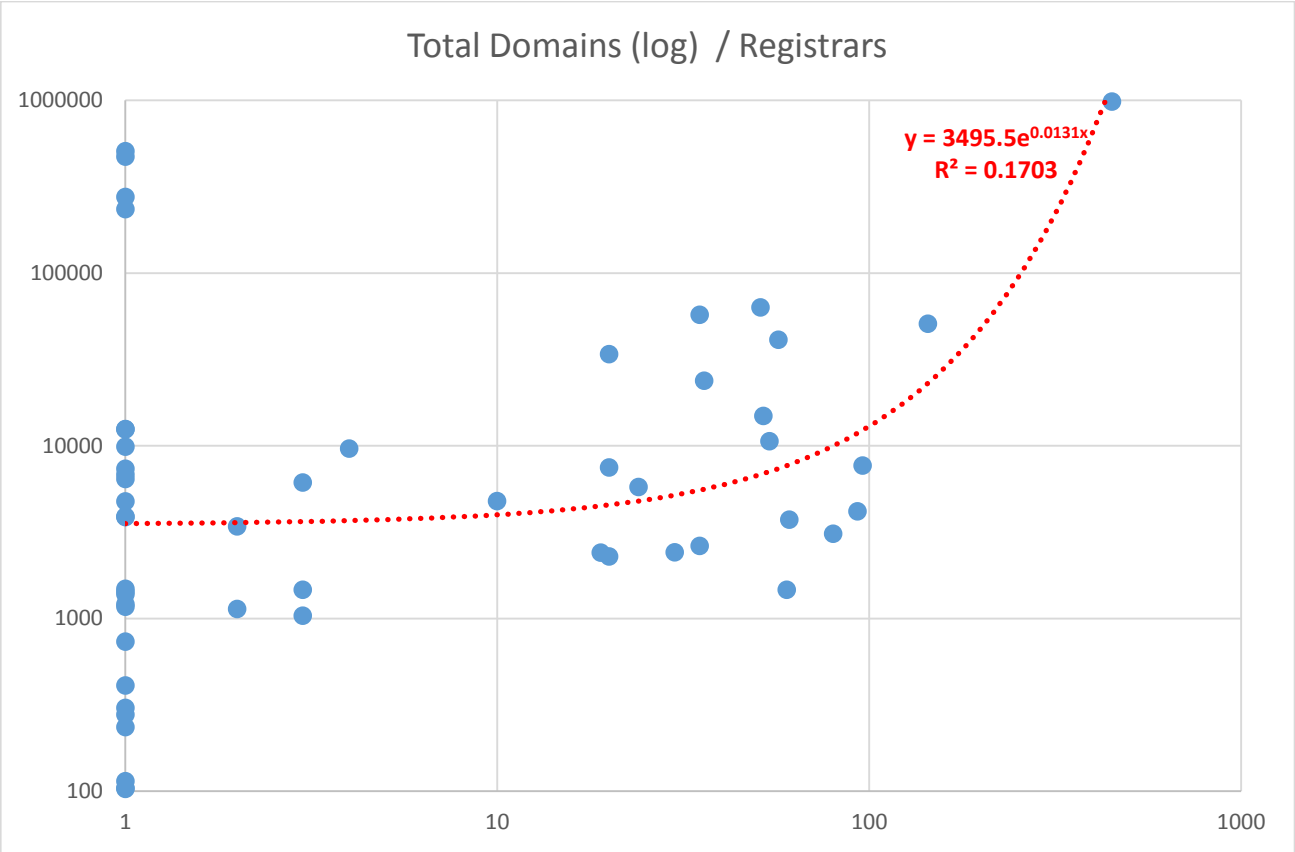
The Registrars for 15 of the ccTLDs do not take registrations for entities without a local presence by the Registrant in the relevant country. In total 33 ccTLDs are available for out of country registration. For four countries, it is unclear whether local presence is required, and in two

[134] In the 3R model, it is usual for the Registry to "accredit" Registrars as having signed the appropriate contracts and passed conformance tests. In the South African case, this is by the ZACR

countries no local or foreign registration process was identified (Comoros (KM) or Eritrea (ER)) at all.

It would seem logical that the more Registrars there are selling a ccTLD, the more domains will be sold – at least up to some limit. However, if we consider all countries then the graph is very "noisy", with 26 countries on the Y Axis with only one Registrar (Usually the Registry itself) and the correlation is correspondingly low. Note that this is a logarithmic plot.

Figure 6-7: Total Domains versus Registrars (Log Plot)



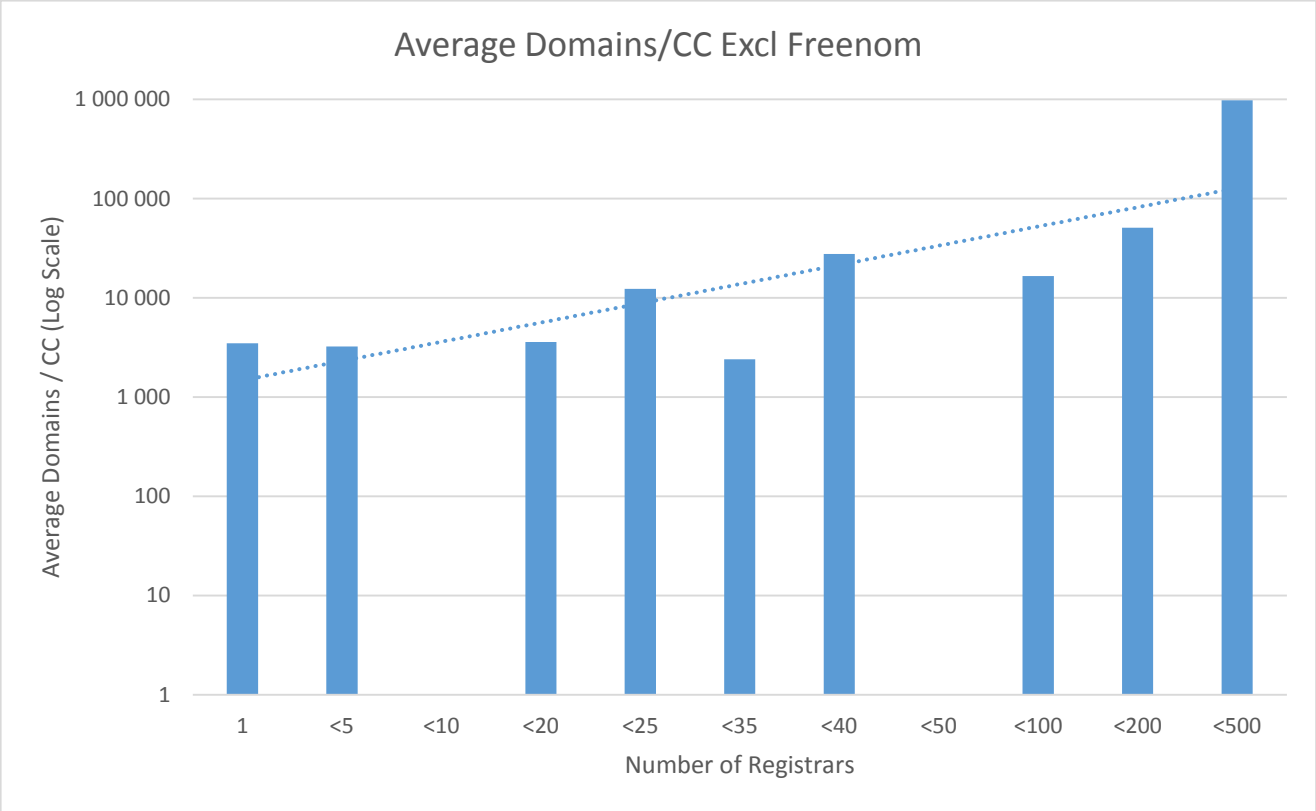
If the Freenom countries are excluded, it would appear that there is no difference in the average number of domains registered per country, for up to 20 Registrars, at about 3,000 domains each. However, as the table below shows, those countries with more than 20 Registrars have more than triple the number of domains per country. It would appear that there is an inflection point between the 20 to 25 Registrar figures (Rwanda is an exception in this regard, as is Namibia). This may be because the larger number of Registrars forces them to be more competitive, or the causality could operate in the other direction – when a ccTLD's domains are popular, it could attract more Registrars. However firm conclusions on this relationship cannot be made as the last

two rows in the table are Kenya and South Africa, which although they have many Registrars, also have many domains for many other reasons. Both countries have very vibrant Internet industries, largely as a result of being early adopters of IXPs interconnecting competing ISPs.

Table 6-6: Average Domains per Country by Number of Registrars

Registrar "Bucket"	Total Domains	Count of Countries	Average Domains / CC	Country Names
=1	76 722	22	**3 487**	(The rest, excluding the 4 Freenom countries)
<5	22 745	6	**3 791**	CG, EG, GH, LS, SC, SZ
<10	0	0		
<20	7 174	2	**3 587**	BI & MZ
<25	49 315	4	**12 329**	DZ, BW, ET & TN
<35	2 412	1	**2 412**	RW
<40	85 938	3	**27 842**	CD, MA & ZW
<100	149 545	9	**16 616**	CM, GM, MG, MU, NA, NG, SO, SD, TZ
<200	50 867	1	**50 867**	KE
<500	982 520	1	**982 520**	ZA

Figure 6-8: Average Domains per ccTLD excluding Freenom Countries



6.7 IDNs

Support for the IDN initiatives in non-Latin alphabets such as Arabic and Amharic (Ethiopia) is growing in Africa. In North Africa the official language is Arabic, so the orthography employs Arabic script. This system is also used in Middle East countries. The Arabic Internet Names Consortium (AINC) led the initiative to foster the usage of Arabic alphabet.

The Arabic script is the second most widely used alphabetic writing system in the world after the Latin alphabet. Moreover, Arabic script has been adapted to such diverse languages as Persian, Urdu, Turkish, Spanish and Swahili. Nevertheless, it remains below 1% of the total IDN used worldwide.

The first implementation was made by Egypt (مصر) in 2010 followed by Morocco (المغرب) in 2011, Algeria (الجزائر) and Tunisia (تونس) in 2012, and then Sudan (سودان) in 2014. Libya is the most notable Arabic speaking African country without an IDN[135].

See section 7.5 for statistics on the use of different languages by African websites.

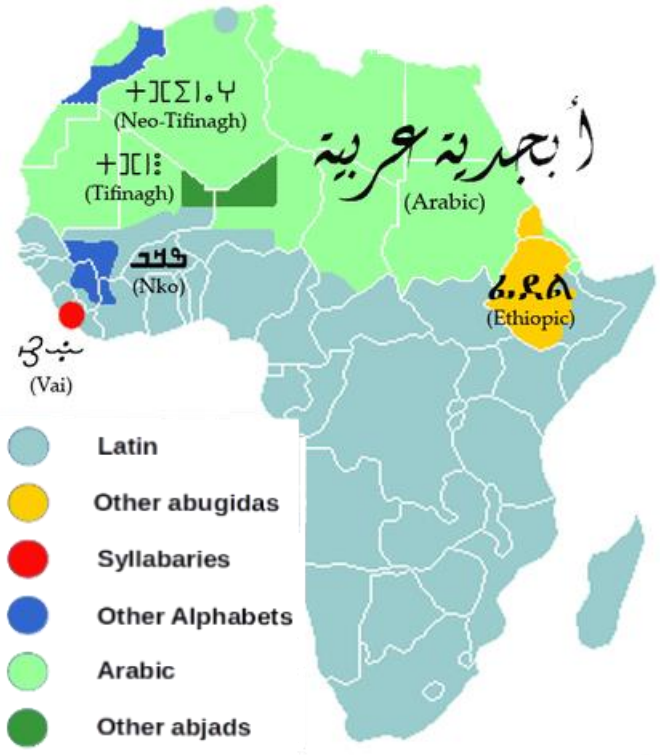
What is an IDN?

The Domain Name System only allows the characters 0 to 9, A to Z and the hyphen to be used to make up a word in a Domain Name (the portion of text between dots). The A to Z characters are also case insensitive. The dot character is used to separate between the different levels (words) of a fully qualified domain name. The hyphen cannot be used as the first or last character of any word. The Underscore character is sometimes used as the first character in service identifiers but is otherwise not considered to be an allowable character in a Domain Name. This has not changed with the introduction of IDN Names.

If we look at the word **café** (the '**e**' having an acute accent '´' over it), in order to represent this in the rules discussed, it needs to be encoded (named "Punycode"[1]) in some manner so that only allowed characters are used. In this case, **café** becomes **xn--caf-dma** or **café.africa** becomes **xn--caf-dma.africa**. An obvious resulting rule from all this is that the initial string **xn--** is reserved for IDN names only, for example, one should not be able to register **xn--123**.

[135] https://eurid.eu/media/filer_public/d0/ad/d0ad22df-e168-47f3-a647-ea1bd44391d6/idnworldreport2015_interactive.pdf

Figure 6-9: Writing Systems in Africa[136]



6.7.1 Privacy Support in Domain Registration

A Privacy System (in the WHOIS system) is where the Registry hides the identity of (usually) the Registrant. The usual reason is that the Registrant does not want to have his / her personal contact information visible in the WHOIS system that anyone with Internet access can potentially see. One example could be that the Registrant is a minor, another is to minimise spam.

In the questionnaire, we asked the following questions and received the following responses:

- Registry: Do you provide Proxy Privacy facilities for WHOIS?
  - Zero Registries out of 26 said "Yes"
- Registrar & Reseller: Do you offer Proxy registration services?
  - 13 out of 54 Registrars and Resellers said "Yes"
- Registrant: Have you ever been offered Proxy Registration services?
  - 83 out of 176 Registrants said "Yes"

[136] Adapted from http://en.wikipedia.org/wiki/File:WritingSystemsoftheWorld4.png

In some Registry systems, it may be possible to ask the Registry to hide certain fields. No one who answered the questionnaire seemed to indicate this would be possible. This should not be seen as a problem, as hiding personal data can be done in other ways.

The easiest way to implement this is for the Registrant to use a proxy contact instead of their own contact details. This would be like having a Post Office Box rather than street delivery for your postal mail. A variety of people can offer these services, from the parents of minors to the company lawyer.

6.8 The User Experience

A positive user experience of the DNS registration system is likely to be a key factor in the uptake of Domains. Registrants who experience the process of DNS registration as simple, speedy and effective are likely to be encouraged to register more domains than those who find the experience complicated, time-consuming and full of pitfalls.

Registrants who find the process simple, quick and effective are likely to register more domains

Conversely, the user experience is likely to provide a key metric of the health of the DNS ecosystem. Those countries with well-performing DNS markets are likely to see this reflected in the levels of user satisfaction within that system.

The nature of the user experience is rather simpler in the two-tier 2R model, where **R**egistrants (some of whom may be resellers) interact directly with the **R**egistry, and where there is a single interface to manage effectively. This model is used in the 26 countries that do not have any Registrars. This model illustrated in the diagram below.

Figure 6-10: "2R" Registry Model

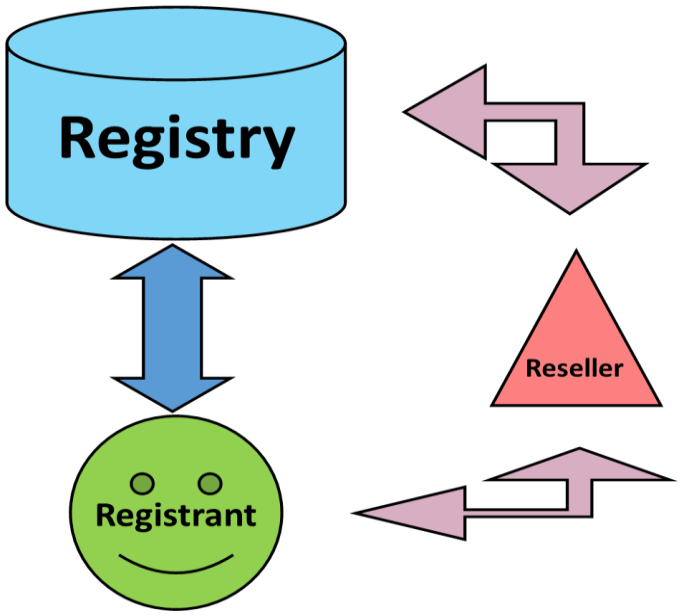
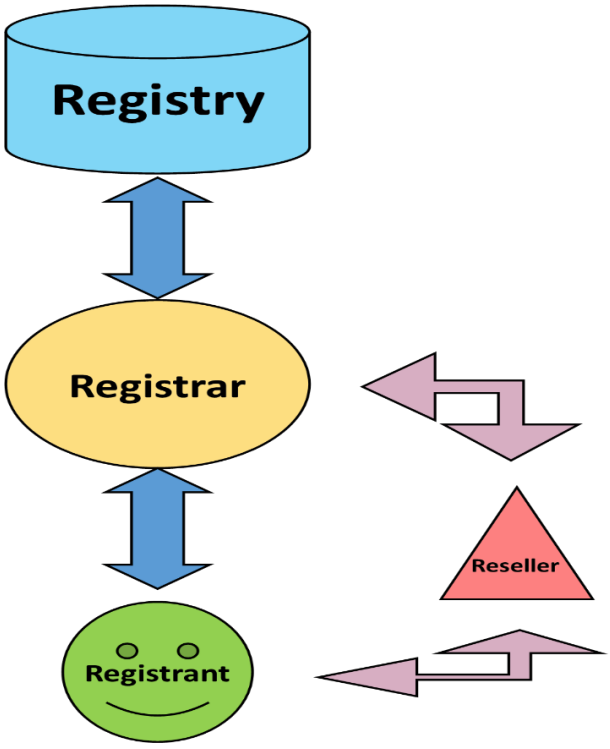


Figure 6-11: "3R" Registry Model



The more complex 3R model (**R**egistrar -**R**egistry – **R**egistrant)[137], usually seen in more developed DNS markets and considered international best practice, presents two interfaces that need to be managed (Registrar-Registry and Registrant-Registrar). Note that while the image below depicts only one Registrar, in practice there are likely to be many.

Problems or bottlenecks at either of these interfaces are likely to impair the function of the process as a whole. However, by separating the widely differing requirements of the Registry from those of the many Registrants, the 3R model usually improves efficiency.

While a Registrar is usually accredited by the Registry as conforming to the required technical, financial and legal standards, a reseller does none of these. Note that in both cases, a reseller can interpose itself between the Registrant and the next layer above. However, for this to be successful in the long term, the reseller must add value to the transaction for the Registrant. The Reseller will frequently do so by offering better value web hosting and email packages to the Registrant, for example.

For these reasons, a number of questions pertaining to factors influencing the user experience were included in the questionnaires. Questions covered issues such as:

- Preference for local or international registrars;
- Preferred payment methods;
- Understanding of the Domain Name registration system;
- Ease of use and awareness of the Domain Name registration system[138];
- The turnaround time for local Domain Name registration;
- The availability and functioning of an EPP (or another API[139]);
- The availability of Premium Domain registration.

Responses were received at all levels: from 13 Registries, from 41 Registrars across 14 countries, and from 164 Registrants across 25 countries. The responses are discussed below, supported by graphs where this is useful.

6.8.1 Registries, Registrars and Registrants

A substantial majority of Registrars (71%) support languages other than English, something likely to facilitate DNS uptake in non-Anglophone countries. About half (51%) say they offer a

[137] E.g. Kenya, Sudan, South Africa and Malawi.
[138] Worded differently for Registrars, who were asked to judge whether their system was "intuitive, automated and user-friendly".
[139] Extensible Provisioning Protocol and Application Program Interface, respectively.

Content Management System with their website hosting packages, which simplifies website development, and again facilitates DNS uptake.

The availability of Internationalised Domain Names (IDNs), which is likely to facilitate uptake in countries with non-Latin script, especially Arabic-speaking countries, is more common than might be expected, reportedly being offered by nearly half of Registries (46%)[140] and a third of Registrars (34%). However, this is likely in response to demand from Registrants, about half of whom (49%) report having made use of IDNs.

91% of Registrants prefer to deal with local Registrars

Overwhelmingly, Registrants (91%) prefer to deal with local Registrars, suggesting the importance of developing the in-country DNS market.

Registrants were asked to rank how easy they found it to locate a local service provider on a Likert-type scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The most common response (mode) was the intermediate score of three, but the scores average out at 3.5[141], indicating a fair degree of ease with which local service providers were able to be found.

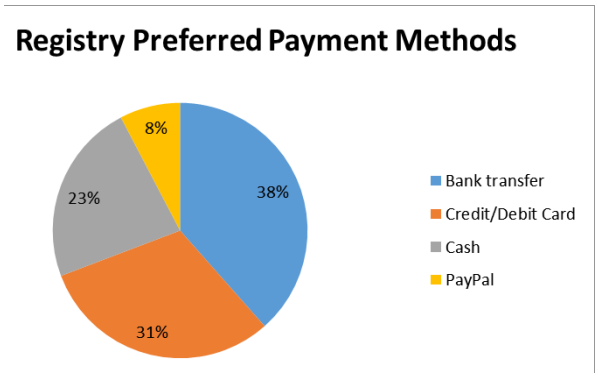
The vast majority of Registrants work with either a single Registrar (41%) or two Registrars (20%). It is unclear why as many as 16% report working with no Registrar, unless these responses are from countries with a 2R model. A small minority (8%) work with five or more Registers, with two working with as many as 30.

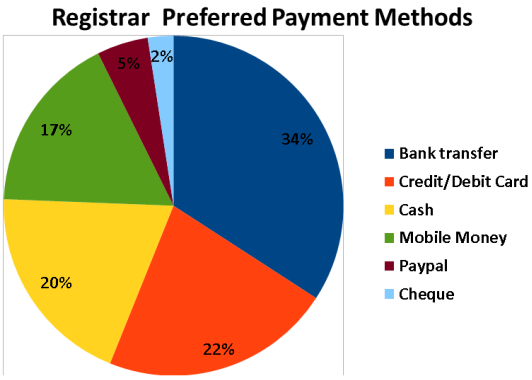
6.8.2 Payment methods

Registrars and registrants were asked their preferred method for payments[142]. In both cases, as the pie chart below shows, bank transfer, followed by credit / debit card, are the clear favourites. Somewhat surprisingly, given its inhibiting impact on the speed and efficiency of registration transactions, cash comes in third for both entities. Mobile money was the unanimous preference for Kenyan Registrars, which is perhaps unsurprising given the role of M-Pesa[143] in the Kenyan economy[144].

[140] Including some surprising ones such as Burundi, DRC, Kenya and Rwanda.
[141] Mean = 3.52, with a standard deviation of 1.05, showing few outlying (negative) scores.
[142] Unfortunately this question was not posed to Registrants. And it was unclear, for Registrars, whether the question referred to incoming (from Registrants) or outgoing (to Registries) payments.
[143] M-Pesa is a mobile phone-based money transfer mechanism. See https://en.wikipedia.org/wiki/M-Pesa
[144] It was also favoured in Côte d'Ivoire and Cameroun.

Figure 6-12: Preferred Payment Methods, Registries & Registrars





6.8.3 Understanding DNS registration

Registrants were asked to rate whether they understood the choice of Domain Name available to them on a Likert-type scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree")). It is clear that most Registrants understood this aspect of the DNS environment well, with the most common response (mode) being 'strongly agree', and the average score coming in at 3.86[145], with very few strongly negative views.

6.8.4 Ease of use

A surprisingly low number of Registrants (37%) rated their process as being "intuitive, automated [and] user-friendly", given that an effective registration interface is likely to be key to ease of DNS uptake. It is not clear whether they saw the fault as being their own, or lying with the Registries.

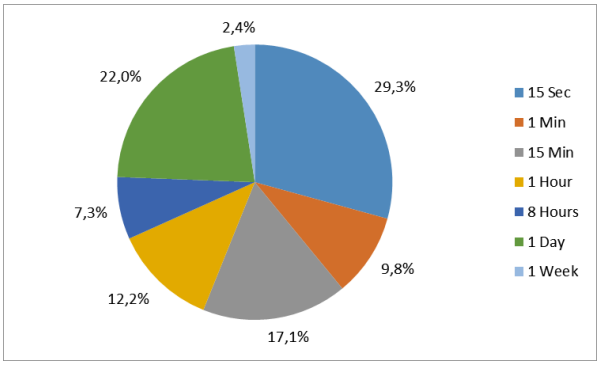
Registrants were asked to rate how easy they found it to register their Domain Name ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The responses show that almost all Registrants found the DNS process easy to use, with and average score of 3.9[146] and few negative ratings.

[145] Mean = 3.86, with a standard deviation of 1.02, showing limited variation in the responses.
[146] The mode (most common response) was a high 5, with a mean of 3.88 and a very low standard deviation of 0.96.

6.8.5 Turnaround time

A surprisingly large percentage of registries reported very fast turnaround times for the registration of local Domain Names, with 39% saying it takes a minute or less, and only a quarter (24%) saying the process takes a day or more.

Figure 6-13: Time to register a local Domain Name (Registrars)



Registrants were asked to rate their ability to make immediate use of their Domain Name, once it was registered ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Again, most respondents found they were able to make immediate use of their newly-registered Domain Name. The intermediate rating of 3 was the most common response (mode), with the average score being 3.6[147], and relatively few negative scores.

6.8.6 Automated registration

73% of Registrants say automated registration is available via EPP or another API.

6.8.7 The availability of Premium Domain registration

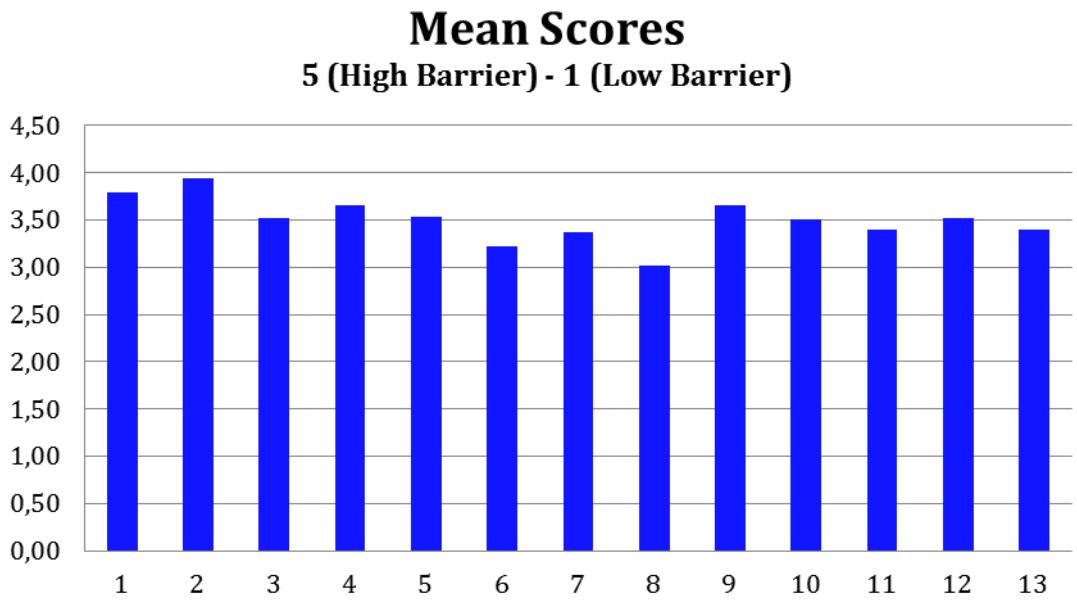
Most Registries (59%) say they offer Premium Domain Name registration.

6.8.8 Barriers to Growth in the DNS Market

All respondents were asked to rank the most significant potential barriers to the development of the DNS market, from most significant barrier (5) down to least significant barrier (1). The results are presented in the graph below.

[147] Mean = 3.63, with a low standard deviation of 1.04.

Figure 6-14: Barriers to DNS Market Development



Key

1. Low Internet penetration (Mode = 5, Mean = 3.79, Std dev = 1.20)
2. High price (Mode = 5, Mean = 3.94, Std dev = 131)
3. Slow processing time (Mode = 5, Mean = 3.53, Std dev = 1.33)
4. Lack of simple Payment Mechanisms (Mode = 5, Mean = 3.66, Std dev = 1.25)
5. Quality of Technical Support (Mode = 5, Mean = 3.53, Std dev = 1.28)
6. Availability of local Registrars/Resellers (Mode = 3, Mean = 3.32, Std dev = 1.32)
7. Government interference (Mode = 5, Mean = 3.37, Std dev = 1.39)
8. Absence of local IXPs (Mode = 3, Mean = 3.02, Std dev = 1.35)
9. Poor dependability of Internet connections (Mode = 5, Mean = 3.65, Std dev = 1.24)
10. Clarity of Policy Environment (Mode = 3, Mean = 3.51, Std dev = 1.27)
11. Restrictiveness of Policy Environment (Mode = 3, Mean = 3.40, Std dev = 1.28)
12. Clarity of Regulatory Environment (Mode = 3, Mean = 3.52, Std dev = 1.22)
13. Restrictiveness of Regulatory Environment (Mode = 3, Mean = 3.40, Std dev = 1.26)

The distribution of the mean responses is surprisingly even, suggesting that all the issues listed rate as significant barriers in a number of DNS markets, and that no single issue dominates across all countries. However, price does emerge as the most significant barrier by a small margin, ahead of low levels of Internet penetration, and the lack of easy payment mechanisms.

It seems prudent that Registries and Registrars should reduce DNS pricing and simplify payment mechanisms as first steps to promote DNS uptake, and that regulators and policy-makers should promote Internet infrastructure development and uptake. However, each of the issues identified above seems to require attention.

Price is the most significant barrier

6.8.9 In conclusion

Taken together, the responses at all three levels indicate a DNS registration process (in the countries that responded to the survey) that is well-understood, appropriate to the local environment, easy and quick to use. It seems that moving entirely to electronic payment systems and reducing the price of registration will be well supported by the market. The role of policy and regulation in providing a stable environment conducive to increased levels of Internet uptake and usage should also be noted.

As a caveat, it should be noted that responses to the questionnaire are likely to be weighted in favour of those countries with relatively effective and efficient DNS markets. Further research is required to pinpoint the problems in poorly performing DNS markets.

6.9 Premium Domain Names

A Premium Domain name is a Domain that the Registry sells at a higher cost than normal domain names, from the same zone. The types of names that may be considered Premium are usually either short names (three or fewer letters) or common dictionary words, also known as generic names (e.g. green, travel, shopping). Thus, short[148] or generic names usually cost more. This could be regarded as a tool to reduce Domain Name speculation, so that the Registry receives the income rather than the speculator[149]. It could also be regarded as a controlled levelling mechanism for pricing under Registry control rather than under speculator control. Premium Domains do not necessarily help increase Domain Numbers but they may well increase Registry profits.

[148] Technically, in the standard 7-bit ASCII alphabet, there are 36 one character names (0-9 and a-z), 1,296 (36^2, that is 36 to the power of 2) two character names and 47,952 three character names (36^3+36^2). The three character names can also include the hyphen character ('-') in the middle position (the "+36^2" factor in the formula above). The hyphen character is not allowed to be either the first or last character of a Domain name. This could thus allow for 49,284 Premium names in total – with three or fewer characters in the Latin alphabet set. The number of permutations would be increased if other accented characters are included, where IDN (Internationalised Domain Name) is allowed.

[149] There many companies that specialise in selling Premium Domains – e.g. http://www.domainmarket.co.za/ . In many cases these are sold simply as an investment, so "squatting" must also be allowed.

In the questionnaire, we asked the following questions, with the answers shown:

- Registry: Do you sell Premium Domain Names (using the EPP[150] Premium Domain Name extension)?
  - 3 of the 13 country Registries that responded said "Yes": South Africa, Burundi and Morocco. At least Nigeria is also known to provide Premium Domains.
- Registrar & Reseller: Can you register Premium Domains, for example in EPP via appropriate extensions?
  - 18 out of 35 Registrars offer Premium Domains to their customers – 16 of which use EPP to do this. The other two Registrars probably unknowingly use EPP via the Registry web interface
- Registrant: Were any of your Domain Names purchased as Premium Names (e.g. short or generic names)?
  - 65 out of 179 Registrants have purchased Premium Domains

One common and effective way to implement Premium Domains Names is for a Registry to use an EPP based Registry System. The Registrar is also most likely to use an EPP based client in order to register such domains. The EPP specification forces the Registrar to first look up and then confirm the price of a Premium Domain in the purchase process – so that the Registrant is made well aware at the time of purchase that the domain name is a Premium Domain Name rather than just a standard name.

It is also often true that many countries operating a hierarchical zone structure, with registration allowed at the 3rd level, under the usual .CO.ccTLD, .ORG.ccTLD, etc., also accept registrations at the 2nd level of the ccTLD, often at premium prices.

The most pronounced version of these is in Namibia, where the premium for a domain at 2nd level - i.e. [name].NA is available for USD 5,749.99/year, while a domain under .COM.NA costs USD $799 per year, and a .CO.NA domain only costs USD $134. Similarly in Nigeria, .NG costs USD $199 per year versus .COM.NG at USD $58 per year. An example of the premium charged for 1 and 2 letter domains is in Sao Tome e Principe (ST), where 1-letter domains are available for USD $6,500 per year and 2-letter domains are available for USD $2,000 per year.

Of the 15 countries that we obtained detailed sub-domain numbers for, some 78% appear to offer Premium Domain Names. Two case studies are outlined below.

6.9.1 South Africa

South Africa has over 1 100 000 domain names registered. The bulk of these are in the CO.ZA registry. There is, as yet, no Registry-based Premium Domain Name system for the CO.ZA Registry. This is probably because all the best names (short and generic names) have already

[150] Extensible Provisioning Protocol RFC https://tools.ietf.org/html/rfc5730

been registered. A few years ago, the ZACR (South African Central Registry) also took over .NET.ZA, .ORG.ZA and WEB.ZA and added these Registries into its EPP system. These 2LDs (Second Level Domains) were re-released and a Premium Domain Name system was activated for each Registry. The system was simple – a single, constant price for Premium Domains and only when it was purchased as a new domain. When the three city Domains (DURBAN, JOBURG and CAPETOWN) were added in the expansion of the new gTLD system, they too had their own Premium Domain Name systems. So, in South Africa, Premium Domains include three and fewer letters as well as a number of Generic names.

6.9.2 Nigeria

In 2015, in order to grow the .NG namespace the Nigerian Internet Registration Association (NIRA) issued over 1,851 .NG Premium Domain Names through an auction process. Although there was interest in those domain names, the cost of acquiring them became a stumbling block to many Nigerian citizens, as the domain names were auctioned at a rate of N15, 000, which at that stage was about USD $75.

Although Premium Domain Names are valuable, as they are the catchiest, there is a need to make them affordable for African entrepreneurs, as the cost of acquiring a Premium Domain Name is still a barrier for many small businesses, non-profit organisations and students.

Apart from South Africa and Nigeria, the continent's leading economies, not many countries in the continent have released Premium Domain Names by auction. There needs to be a multi-stakeholder approach in ensuring that the growth of the Premium Domain Name ecosystem is enabled.

6.9.3 Another Type of Premium Domain Usage

Domaineers[151] some time ago saw that not all Domains were equal and registered them for themselves for the express purpose of monetising them in some way. They are resold at a premium price on the open market - often to a purchaser with a similar name to the Domain. They are often found on systems like Sedo Parking, where they can also be used to run Google Advertising (Domain referrals) from. If a Registry allows for Domain Tasting (the purchase of a Domain for a short period or use of the Domain before having to pay for it, then Domaineers may register numerous Domain for the expressed purpose of running them to see if Domain Referrals will be profitable for that name or not, for example, the incorrect spelling of an existing Domain.

[151] Domaineering is the web-based marketing business of acquiring and monetizing Internet domain names for their use as an advertising medium

7 ANALYSIS OF DOMAIN NAME UPTAKE ACROSS THE REGION

7.1 African DNS Market

While domain names are the primary focus of this study, it is clear that there are a number of interrelated factors that contribute to the health – or lack thereof – of the DNS market within each African country. We found that the various countries were very diverse in how they have succeeded under various metrics. For example Mali, Equatorial Guinea, Central African Republic and Gabon have high numbers of domains as a result of these being given away by Freenom, some have had some success in exploiting their ccTLD's potential for a domain hack, while others have not.

While many indices of various types are published, none of them met the specific requirement of this study to quantify success in the DNS Market in Africa. In addition, few of them consider all 54 countries. For example, one of the best known is the ITU's ICT Development Index[152]. However, it only has data for 39 Africa countries. As a result, we have developed a Country DNS Success Index (CDSI) is based on a combination of the rankings of all 54 countries in Africa on each of the following criteria:

- Number of domains registered under the ccTLD
- Number of gTLD domains identified as having an African Registrant
- Number of webpages indexed by Google
- Price of registration
- Number of Registrars
- Number of locally hosted websites
- Figure of Merit (FoM) derived from the presence of one or more functioning IXPs
- Internet usage as a percentage of the population

Note that a simple ranking was used for each criterion, which eliminates some of the enormous differences in scale between African countries. Some explanation of each of these results is outlined in the following sections.

7.1.1 Number of ccTLD Domains

While this may seem an obvious measure, a number of countries have an unusually high number of domains, as discussed in section 6.3.3. In addition, there are several countries with unusually

[152] http://www.itu.int/net4/ITU-D/idi/2016/

low numbers of domains, as discussed in section 7.4. Thus, while the number of ccTLD domains is important, it isn't sufficient in itself. The total number of domains is counted, irrespective of the population size of the country. As will be shown later, this does not seem to disadvantage countries with smaller populations.

7.1.2 Number of gTLD Domains

Having more gTLD domains than ccTLD domains for a country could be seen as an indication that the ccTLD is not doing well. While this is true, the mere fact that domains are being registered is an indication of the vibrancy of the local ICT ecosystem.

7.1.3 Number of Web Pages Indexed by Google

This is a crude measure of the total volume of content appearing under a ccTLD. For those countries not listed in Section 6.3.3 as a "domain hack", this is indeed a useful measure of the quantity (if not the quality) of local content. A number of the "domain hack" countries have a higher volume of webpages than expected. This is presumably because those entities that have taken the trouble to register a clever domain name have also taken the trouble to use it effectively.

7.1.4 Cost of Registration

For this important metric, countries were ranked from cheapest to most expensive. It should be noted that analysis showed two different measures of price: that offered by a typical international Registrar; and that offered by local Registries, Registrars and Resellers. In both cases we picked the lowest figure, so the results were not distorted by Premium Domain Names, for example.

These two ranges of figures are not strictly comparable. The former typically includes the full cost of registration and annual DNS hosting, whereas the latter often only includes the cost of the first part of the registration process.

7.1.5 Number of Registrars

While this is an important metric, it can be overplayed. Clearly, 25 Registrars is better than one Registrar. But are 50 Registrars better than 25? In section 6.6 we attempted to answer this question, concluding that having the highest number of registrars is not necessarily the ideal, but that there was a distinct difference between those countries that had significantly fewer and 25 Registrars versus those with more. For the index, countries were simply ranked on the number of Registrars we were able to identify. The 26 countries with a single Registrar each were ranked equally.

7.1.6 Local Hosting

Countries where few local domains and websites are hosted locally do not have a healthy ICT ecosystem. This metric is ranked in descending order of the total number of websites hosted locally, which almost matches the proportion of websites that are hosted locally. The exceptions are Malawi and Libya, ranked 8th and 9th, with 39 and 38 (8% and 17%) websites hosted locally respectively, out of very small totals.

7.1.7 IXP Figure of Merit

As discussed in section 5.4.3 above, the presence of an IXP is without doubt a very important factor in the ICT ecosystem of a country. However, the effect of an IXP can be complex, and clouded by many issues. We thus derived a Figure of Merit (FoM) for those countries that have one or more functioning IXPs. Those without a qualifying IXP scored nothing on this metric.

7.1.8 Internet Penetration

As discussed in Section 5.3, the percentage per capita of Internet usage, or penetration, is an important measure of how developed the ecosystem is. Kenya leads in this metric, with 60% of its population having access to the Internet. The simple fact of having access leads to a number of economic benefits.

7.2 Ranking of all 54 Countries

Looking at all 54 countries, for all eight parameters, allows us to rank all African countries in terms of their success in the DNS Ecosystem. The results are as follows: -

Table 7-1: Ranking of All 54 Countries

Total ccTLD Domains	Total gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Rank
ZA	ZA	ZA	TN	ZA	ZA	ZA	KE	1
GA	NG	KE	ZA	KE	KE	TZ	MA	2
CF	EG	ZW	KE	MA	MU	KE	MU	3
GQ	MA	UG	CF	EG	MG	EG	SC	4
ML	SC	NG	GA	TN	SD	NG	SN	5
CM	KE	EG	ML	ZW	NA	UG	NG	6
MA	GH	MA	GQ	CM	GM	DZ	ZA	7
KE	DZ	LY	ET	MW	NG	RW	TN	8
NG	TN	MU	CM	LY	TZ	MZ	ZW	9
TN	NA	CD	ST	DZ	SO	CD	CV	10
ZW	UG	GH	DZ	TZ	CM	ZW	GA	11
SO	MU	SC	SN	MU	ZW	BW	LY	12
LY	ZW	DZ	UG	NA	CD	GH	EG	13
ST	SN	ST	GW	UG	MA	MU	UG	14
TZ	CM	SN	TG	BW	RW	ZM	GH	15
MW	TZ	NA	MA	SN	DZ	TN	AO	16
EG	AO	TN	NG	CI	BW	MW	BW	17
MU	ZM	GQ	BI	MG	ET	SD	DZ	18
BW	BJ	BW	ZW	GH	TN	BJ	SZ	19
CI	ET	RW	CD	GM	BI	GM	SD	20
DJ	BW	SO	SD	NG	MZ	CI	RW	21
UG	LY	CM	SO	CD	EG	CG	ST	22
SC	MZ	GA	BW	CV	LS	NA	GQ	23
DZ	BF	MZ	SL	RW	SC	MG	CI	24
MZ	MG	CF	MW	TG	SZ	BF	NA	25
SN	RW	DJ	CV	TD	CG	DJ	GM	26
MG	TG	ZM	ZM	MZ	GH		ZM	27
ZM	SO	TZ	KM	BI	AO		CM	28
AO	CI	CI	MU	ET	BF		SS	29
NA	MW	SD	GM	CG	BJ		TZ	30
GH	ML	AO	LY	SZ	CF		LS	31
SD	GA	CV	SC	AO	CI		MR	32

Total ccTLD Domains	Total gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Rank
CD	SZ	MG	BJ	ZM	CV		DJ	33
RW	SD	BI	DJ	BF	DJ		BJ	34
BI	CD	ET	TZ	SC	ER		BF	35
ET	TD	ML	CI	SS	GA		LR	36
MR	MR	MW	LR	SO	GN		CG	37
GM	CG	GM	MR	ST	GQ		KM	38
SZ	BI	LS	SZ	DJ	GW		ML	39
SL	GN	BF	MG	SD	KM		GN	40
CV	SL	NE	EG	MR	LR		MW	41
BF	NE	MR	MZ	SL	LY		MZ	42
TG	CV	SZ	NA	LS	ML		TG	43
CG	GM	BJ	BF	BJ	MR		BI	44
LS	KM	SL	GN	NE	MW		SO	45
BJ	LR	TG	GH	LR	NE		MG	46
NE	CF	TD	AO	GN	SL		SL	47
LR	DJ	CG	LS	GW	SN		ET	48
GN	GQ	LR	ER	ML	ST		CF	49
TD	ER	GW	NE	GQ	TD		GW	50
GW	LS	GN	RW	CF	TG		CD	51
ER	ST	KM	CG	GA	UG		TD	52
KM	GW	ER	TD	ER	ZM		NE	53
ER	SS			KM			ER	54

Each country received a score for each ranking, starting at 54 for the top-ranked country and decreasing to 1 for the bottom ranked. The total score per country is simply the sum of the scores for each metric. It is clear that the same small group of countries score well on almost all metrics. However, in each one, there are some surprising results.

The top 20 countries by total score were: -

Table 7-2: Top 20 Countries

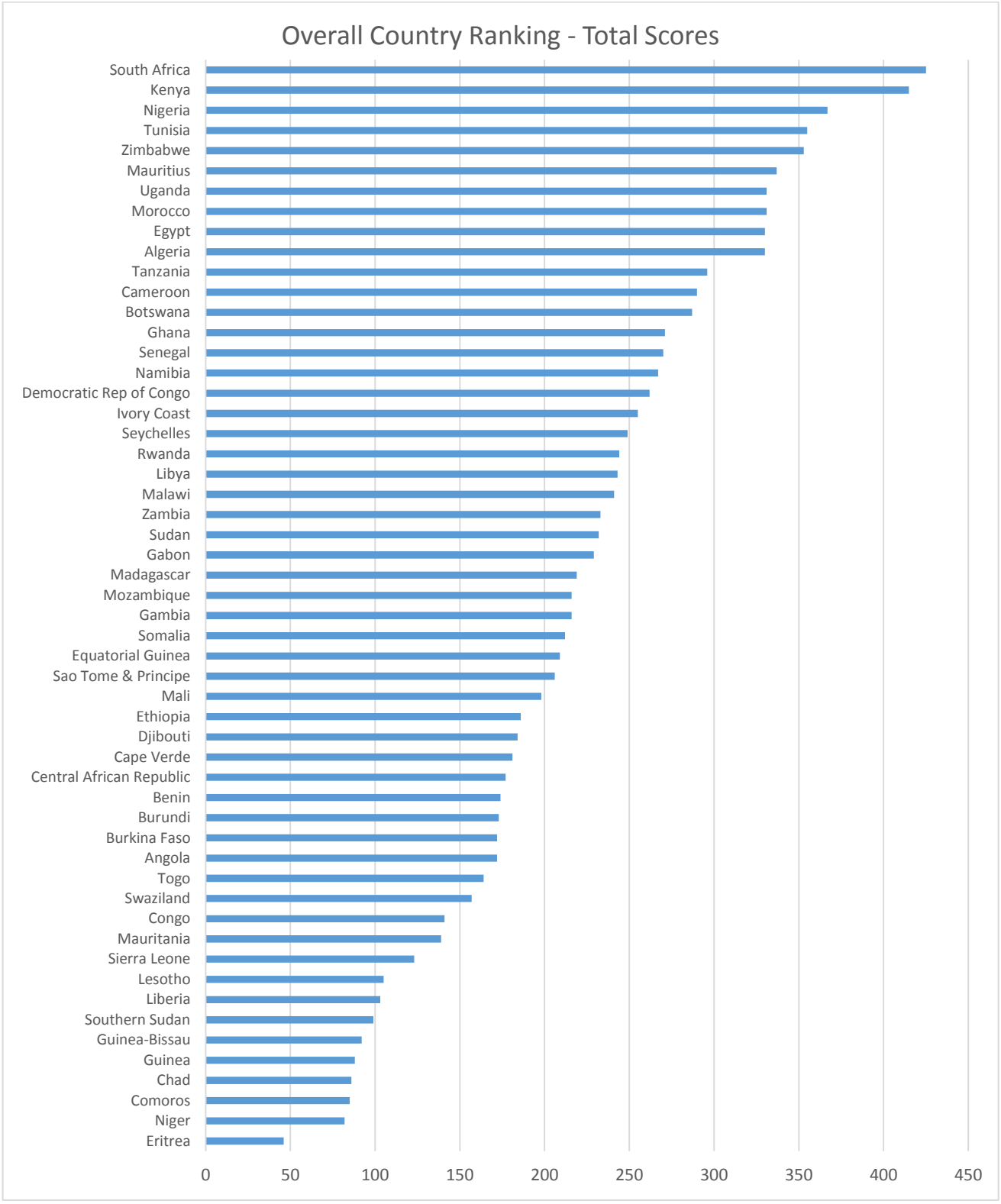
Country	Total Score	Language	Region
South Africa	425	English	South
Kenya	413	English	East
Nigeria	367	English	West
Zimbabwe	356	English	South
Tunisia	355	Arabic	North
Mauritius	340	English	Indian Ocean
Algeria	333	Arabic	North
Morocco	332	Arabic	North
Egypt	330	Arabic	North
Uganda	328	English	East
Botswana	297	English	South
Tanzania	294	English	East
Cameroon	287	French	Central
Namibia	274	English	South
Ghana	271	English	West
Senegal	269	French	West
Democratic Rep of Congo	262	French	Central
Ivory Coast	255	French	West
Seychelles	249	French	Indian Ocean
Rwanda	244	English	East

The chart indicates there are no obvious advantages according to region, but language does seem to have an influence. It is worth noting that 14 of the 20 high performing countries listed above appear in the first 20 entries of Table 5-1 as being earlier adopters of IXPs and still have at least one viable IXP in operation today. A summary of the results by region and language follows in Section 7.5.

19 out of the top 20 Countries have access to an IXP

The scores achieved by all African countries are shown in the bar chart below.

Figure 7-1: Overall Country Ranking and Scores



Although not included in the scoring, other factors that could affect how well a country fares include:

- Number of AfriNIC Members
- Number of ASNs
- Literacy rate of the population
- Government Stability and level of Democracy
- Average income
- State of ICT sector reform
- Level of regulatory effectiveness
- Relevant legislation on e.g. e-commerce, digital signatures, DNS management & regulation, and privacy protection.

7.3 High Performing ccTLDs

An examination of the top ten countries in terms of the Study's ranking of DNS ecosystem success follows below.

For each country, we provide:

- Scores for each of the eight ranking criteria in a table, with the total score highlighted
- Statistics from http://africa-map-2017.telegeography.com (2015)
  - Operational international bandwidth (Gbps) in 2015 --> forecast for 2018
  - Population (millions) / Households (millions)
  - Users by technology: Fixed line,% Broadband%, Mobile (millions of SIMS)
- Undersea cable names (where appropriate)
- GNI per capita estimate (World Bank) as shown at http://www.internetworldstats.com/af/XX.htm (where XX denotes the two letter ISO code for the country)
- Statistics from: http://www.internetworldstats.com/stats1.htm Internet penetration %

7.3.1 South Africa (ZA)

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
ZA	54	54	54	53	54	54	54	48	425

- International Bandwidth: 512 --> 1414
- Population: 55 / 15.3

- Technology: 26%, 12%, 164
- Cables (5): (West Coast) WACS, SAT-3/WACS. (East Coast) EASSy, SEACOM, SAFE (Far East)
- GNI: US$ 6,050 for 2016
- Internet penetration: 56.6%

South Africa scored the highest marks in every category except for price, where Tunisia scored best, and for Internet penetration, where it came in 7th place. South Africa has won an award for best African ccTLD. The reasons for ZA's success include:

- Amongst the first country with:
    - Automated registry systems
    - Relatively highly developed Internet infrastructure and uptake
    - Multiple Internet exchange points and data centres
- Early adopters of:
    - ccTLD delegated in 1993
    - IPv6 addressing from 2006
- Largest number or amount of
    - Domains
    - AfriNIC Members
    - ASNs
    - IP Address space
    - Local Hosting
    - Data Centres

Winners of the first ever African Domain Name Industry Awards at ICANN (Durban) July 2012 with the award panel, sponsored by ICANN in partnership with AfTLD and ISOC Africa.

The availability of high capacity broadband infrastructure in South Africa has improved considerably in urban areas over the last few years. There are now a large number of undersea cables connecting South Africa via both East and West coasts. The telecommunications sector and laws governing it are relatively well developed, and is also home to over 400 licensed telecommunication providers. There is currently a race to deploy fibre to the home in many suburbs, gradually replacing the copper ADSL infrastructure. The quality of data centres has attracted many international Content Delivery Network providers such as Cloudflare, which makes a large portion of the content of the Internet available locally to South Africans with low latency. However, South Africa has fallen behind some other African countries in the last two decades[153]. Google indexes 155 million pages for ZA, which results in 158 pages per domain. Compared with the average of 555 for Africa, this is on the low side.

Although South Africa scores highest in the Study's overall country DNS success ranking as shown above, it is likely to be challenged by a number of other African countries in the future, which are growing faster.

[153] For example, ZA had over half of all Internet users in Africa in 2000. Today, it's in fourth place. See http://www.internetworldstats.com/stats1.htm

7.3.2 Kenya (KE)

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
KE	47	51	53	52	53	53	52	54	415

- International Bandwidth: 228 --> 699
- Population: 44.2 / 12.4
- Technology: 0.7%, 1%, 83
- Cables (3): EASSy, SEACOM, TEAMS
- GNI: US$ 1,290 (2014)
- Internet penetration: 68%

Kenya scored well in all the metrics except for total domains. This is due to the Freenom "domain hack" countries having significantly more domains registered. Coming in second, Kenya has a well-developed Internet industry. There are three undersea cables that link Kenya to the world and other cables that interconnect neighbouring countries. There is also an emerging FTTH industry within Nairobi. KIXP was the second operational IXP on the continent, with a new one in Mombasa commissioned in June 2016. Often, Internet services can be more competitively priced than in South Africa. The Government of Kenya is supporting e-government using the Internet so that services such as visas, passports and driving licence renewals can all take place electronically. This is in contrast with when the Kenyan IXP in Nairobi was first opened and then immediately shut down by government for a few months. Through the support of the Kenya Communications Commission and UNESCO, The Institute of Curriculum Development has begun a digital literacy programme that is expected to connect all 22,000 public schools and equip them with 1.2 million digital devices by the end of 2017. One of the biggest single sources of local traffic is online taxation submissions, which has improved Kenya's revenue collection considerably, with over 2 million users by July 2016, and collection of over Kshs 1 trillion Exchequer Revenue. The next local elections will be relying on Internet connectivity to aid in vote collection. Google indexes a total of 42 million web pages under the .KE domain, or 828 pages per domain.

Kenya is supporting e-government

7.3.3 Nigeria (NG)

CC	Total Domains	Afilias Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
NG	46	53	50	38	34	47	50	49	367

- International Bandwidth: 141 --> 425

- Population: 178.7 / 38.7
- Technology: 0.5%, 0.4%, 83
- Cables (5): ACE, GLO-1, SAT-3/WACS, Main One, WACS
- GNI: US$ 2,950 (2015)
- Internet penetration: 52%

As with South Africa and Kenya, Nigeria has multiple undersea cables. The ccTLD is well run, there is a distributed IXP in Lagos and multiple Data Centres. Nigeria's biggest advantage is its huge population and large economy. It is, however, heavily reliant on oil revenue, which has taken a battering recently. Nigeria has the highest number of Internet users on the continent.

Coming in just after Kenya on the number of domains, Nigeria also has a high score from its two IXPs and the exceptionally large number of Afilias domains. The latter may be a function of Nigeria's large population size, or perhaps is driven by avoiding the stigma of the .NG domain and its association with "419" scams. Although Table 5-1 lists the Lagos IXP at 2007, the now defunct Ibadan IXP started contributing to the growth of the Internet industry in Nigeria in 2002. Google indexes a total of 16 million web pages under the .NG domain, or 381 pages per domain.

7.3.4 Zimbabwe[154] (ZW)

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
ZW	**44**	**39**	**52**	**36**	**49**	**43**	**44**	**46**	**353**

- International Bandwidth: 73 --> 174
- Population: 13.4 / 3.2
- Technology: 10%, 3%, 96
- Cables (0): Landlocked, Liquid Telecom runs fibre from Zambia to South Africa via Zimbabwe and on to EASSy and SEACOM
- GNI: US$ 640 (2011)
- Internet penetration: 46.5%

Zimbabwe is a land-locked Southern African country. It has eight licensed international Internet Access Providers (IAPs) which use two main international links - SEACOM and the Eastern Africa Submarine Cable System (EASSy) via links to South Africa and Mozambique. In addition to the

[154] With additional information from the CO.ZW Registry

IAPs there are a further nine Internet Service Providers (ISPs) who obtain their Internet bandwidth from the IAPs.

There are approximately 50 local Resellers in the .CO.ZW namespace, which has a total of just under 25,000 registered domain names. There is no Registrar accreditation process in place. The other .ZW subdomains are .ORG.ZW (1,350 domains), .AC.ZW (550 domains) and .GOV.ZW (unknown). .CO.ZW registrations can be purchased locally for as little as $2 per year.

The country has a single IXP – ZINX in Harare. It is currently used for local connectivity between members only. However consideration is being given to linking it with regional IXPs, such as JINX in South Africa.

As in many parts of Africa, the Internet Café is a popular method of accessing the Internet. Some of the major cyber cafés in the city centre include Quick n' Easy, InTouch, DC Africa, Telco and the state operated ComOne. In June 2004 President Mugabe asked ISPs to monitor all email traffic passing through their systems for "anti-national activities". ISPs protested that this was an impossible task.[155]

Aside from the country's economic difficulties, the relatively low number of domain name registrations is likely to be a result of the laborious manual registration process, in which a check is made for possible trademark infringements before a .CO.ZW domain is granted. Compare this with South Africa, where out of over one million automatically registered domains, there have been 193 domain name disputes between 2007 and 2016 using the Alternative Dispute Resolution (ADR) service. Before 2007, there were only a handful of Dispute Resolutions that were processed through court. Google indexes a total of 26 million web pages under the .ZW domain, or a very high 1090 pages per domain.

7.3.5 Tunisia

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
TN	45	46	38	54	50	36	39	47	355

- International Bandwidth: 117 --> 324
- Population: 11.1 / 2.5
- Technology: 35%, 19%, 133
- Cables (4): SeaMeWe-4, Trapani-Kelibia, Didon, Hannibal

[155] https://www.theguardian.com/international/story/0,3604,1230096,00.html

- GNI: US$ 3,970 (2016)
- Internet penetration: 52.1%

Tunisia is situated in the north of the African continent and has a well-developed and sophisticated telecommunications and broadband infrastructure. The Internet remains partly free, and while the state-controlled telecom operator maintains a monopoly over the country's domestic Internet backbone, two other service providers have deployed Tunisia's first privately operated fibre optic submarine cable. Tunisia's telecoms regulator, the INT, introduced new licensing regulations recently and continues to make strides towards ensuring greater transparency and accountability.

These regulatory measures and good international bandwidth have led to consumers benefiting from reasonable prices. The Government sees the Internet as an opportunity for e-commerce, e-learning and e-medicine. Google indexes a total of 3.7 million web pages under the .TN domain, or a low 111 pages per domain.

7.3.6 Mauritius (MU)

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
MU	37	40	46	26	43	52	41	52	337

- International Bandwidth: 41 --> 130
- Population: 1.3 / 0.4
- Technology: 104%, 56%, 149
- Cables (2): LION, SAFE (both to the East and West)
- GNI: US$ 9,630 (2015)
- Internet penetration: 59.6%

The island of Mauritius is on the eastern side of the African continent, and ranks among the highest in Africa on Internet penetration. Mauritius is also becoming one of the wealthiest countries in Africa. The business registration, taxation and banking (foreign exchange) laws are oriented to attracting off-shore business to the country. The island is connected to two different fibre cables with more planned. Mauritius has established a digital campus development called Cyber City, which is the location for the headquarters of AfriNIC, the Regional Internet Registry (RIR) for Africa, as well as a number of IT companies, including SEACOM (an undersea fibre cable company).

Mauritius is let down on its score by its high domain price, but does very well on the number of Registrars.[156] Google indexes a total of 7.4 million web pages under the .MU domain, or a high 963 pages per domain.

7.3.7 Algeria (DZ)

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
DZ	31	44	42	44	45	39	48	37	330

Algeria is in North Africa and borders the Mediterranean Sea. This should allow easy undersea fibre connections into Europe. It is the second largest country in Africa, bordered by Tunisia, Libya, Niger, Mali and Mauritania, and Morocco. To improve the Internet penetration rate, the government has started a number of initiatives, including its approval in January 2008 of a €100 million plan to implement Internet networks in every high school in the country. Algérie Télécom is the main telecommunications provider. There appears to be no evidence of Internet blocking except for the al-Qaeda websites.[157] Google indexes a total of 4.8 million web pages under the .DZ domain, or a high 834 pages per domain.

7.3.8 Morocco (MA)

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
MA	48	50	48	39	52	41	0	53	331

- International Bandwidth: 598 --> 1,917
- Population: 33.5 / 6.4
- Technology: 34%, 18%, 124
- Cables (3): SeaMeaWe-3, Atlas Offshore (and one more)
- GNI: US$ 2,970 (2011)
- Internet penetration: 60%

As a relatively wealthy country, being close to Europe on the north-west corner of Africa and with a large tourism industry, Morocco has a relatively high Internet penetration rate of about 60%. It is the only country in the Top Ten without an IXP, but with the proximity of Europe it has good access to international connectivity and European IXPs. Maroc Telecom[158] launched ADSL in

[156] http://www.bbc.co.uk/blogs/worldhaveyoursay/2007/11/prince_and_free_speech.html
[157] https://en.wikipedia.org/wiki/Internet_in_Algeria
[158] https://en.wikipedia.org/wiki/Internet_in_Morocco

October 2003 after tests in November 2002. Subscribers are able to get up to 20 Mbps connections. There are also multiple 3G+ cell phone operators. Google indexes a total of 14.5 million web pages under the .MA domain, or 254 pages per domain.

7.3.9 Egypt

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
EG	38	52	49	14	51	33	51	42	330

International Bandwidth: 602 --> 1599

Population: 88.4 / 18

Technology: 36%, 22%, 106

Cables: 10 cables run through the Suez canal area, but FLAG, SeaMeaWe (3,4,5) AAE-1, ALETAR, MENA, EIG, Flag Falcon, Flag FEA, TE North, Hawk, I-ME-WE are explicitly mentioned as landing in Egypt[159]

GNI: US$ 3,210

Internet penetration: 38%

As Egypt is on the Mediterranean Sea, undersea fibre access to Europe is reasonably low cost, and a number of cables passing through the Red Sea to Africa and Asia land here on their way to Europe. Internet though is controlled largely by the government, as was seen when the country's Internet was switched off during the Arab Spring. On the other hand, the government at one time implemented free (home) Internet access to those with phone lines.

Egypt scores well with Afilias domains, local hosting and its single remaining operational IXP. Google indexes a total of 15.4 million web pages under the .EG domain, or a very high 1603 pages per domain. Only the DRC (.CD) has more, with 2 822 pages per domain.

7.3.10 Uganda (UG)

CC	ccTLD Domains	gTLD Domains	Web-pages	Price	Local Hosting	Registrars	IXPs - FoM	Internet Penetration	Total
UG	33	47	51	42	41	27	49	41	331

- International Bandwidth: 65 --> 265
- Population: 39.9 / 8.2

[159] https://en.wikipedia.org/wiki/List_of_international_submarine_communications_cables

- Technology: 4%, 2%, 47
- Cables (0): Landlocked, access via Kenya
- GNI: US$ 670 (2016)
- Internet penetration: 31%

Being a land-locked country, international access for Uganda is provided via Kenya and Tanzania. There are also onward fibre links to neighbouring countries Rwanda and the eastern DRC. Google has invested in a metro fibre project known as Project Link in Kampala. There is a local IXP in Kampala along with a number of Data Centres. It is not surprising to see Uganda, Tanzania and Kenya in this list – the three countries work closely together as members of the East African Community (EAC).

Uganda does well on Afilias gTLD domains, price, hosting and its IXP. It does exceptionally well on the number of web pages. This is despite it having the lowest GNI per capita of the Top Ten. Google indexes a total of 18 million web pages under the .UG domain, or 536 pages per domain.

7.4 Underperforming ccTLDs

This section provides analysis of underperforming ccTLDs – those with less than 1,000 registrations – with the aim of identifying countries that need special support and issues which could be addressed to improve the performance of the domain name industry. Although these countries are presented here in ascending order of the total number of ccTLD domains, this does not directly correlate with their overall rankings as shown in Section 7.2 above. It is worth noting that none of these countries has a functional IXP, except for Benin, which has one, but it is only three years old and has few peers.

Note that similar statistics are presented here for each country as were shown in the top performing countries in Section 7.2.

7.4.1 Comoros (KM) – 103 Domains

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
KM	2	8	3	27	1	27	0	17	85

- International Bandwidth: 1 --> 2
- Population: 0.8 / 0.2

- Technology: 13%, 0.5%, 55
- Cables (3): EASSy, LION2 (and Comoros Domestic Cable System and Avassa interconnecting the various islands)
- GNI: US$ 790
- Internet penetration: 7.6%

The Comoros registry is managed by Comoros Telecom – the national incumbent operator in this Indian Ocean island state. There were no answers to the questionnaire from the Comoros. There are a large number of options under which domains can be registered, as shown in the table below. Domains cost upwards of USD $68/ year.

Table 7-3: .KM Sub-Domains

.km	Business and Trademarks
.coop.km	Cooperatives
.asso.km	Associations
.nom.km	Individuals
.presse.km	Media organisations
.tm.km	Trademarks
.medecin.km	Medical Professionals
.notaires.km	Legal Professionals
.pharmaciens.km	Pharmacies
.veterinaire.km	Veterinary Professionals
.edu.km	Universities and research institutions
.gouv.km	Government
.mil.km	Military

The website http://www.domaine.km appears to have been designed many years ago and has not been updated since. A ticker tape display lists a "new" event dated April 2011. Domain registration takes place by completing a paper document, but there is no obvious email address to send the application to. This is probably one of the reasons why there are so few domains, exacerbated by the low level of Internet penetration (only 6.5% in 2013), the lack of hosting facilities and the limited number of Internet service providers in the market. Google indexes a

total of 25 500 web pages under the .KM domain, a rather high number for only 103 identified domains, giving 248 pages per domain.

7.4.2 Eritrea (ER) – 104 Domains

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
ER	3	5	2	6	2	27	0	1	46

- International Bandwidth: 0.1 --> 3
- Population: 6.7 / 1.2
- Technology: 5%, 0.9%, 8
- Cables (0): No Cables.
- GNI: US$ 480
- Internet penetration: 1.0%

Eritrea does not have any fibre connections

Eritrea is the lowest scoring country in terms of the Country DNS Success Index, with a score of 46. This is just over half of the score of the next country up, Niger (NE). The Eritrea registry is maintained by the incumbent state telecom operator (and only Internet service provider). The IANA database has no URL for the registry, and guessing at names such as "nic.er" and "noc.net.er" give no replies. The administrative and technical contacts have Yahoo and Gmail based email addresses, rather than addresses using their ccTLD, and did not respond to requests to fill in the survey questionnaire.

A number of second level domains exist although there is no information available about their exact purposes or restrictions. The domains are: .COM.ER, .EDU.ER, .GOV.ER, .MIL.ER, .NET.ER, .ORG.ER and .IND.ER. Although several international Registrars list .ER domains, and some even give a price, they all state that registration is not possible. Given the large number of English language words that end in 'er', it appears that Eritrea is missing a major opportunity to gain 'domain hack' revenue from its ccTLD.

Eritrea does not have a connection to any submarine or terrestrial fibre cables and depends on expensive satellite capacity. As a result Internet connectivity is minimal and its web presence is virtually non-existent – Google indexes a total of 319 web pages under the .ER domain, or about 2 pages per domain. Other factors are a low level of literacy (20%), no independent media and the predominant languages being Tigrigna and Arabic, neither of which were easily used in the

digital world until very recently. The generally isolationist policies of the current regime along with the relatively small population and low per capita income further suppresses investment in ICT infrastructure.

7.4.3 Guinea Bissau (GW) – 114 Domains

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
GW	4	3	5	41	7	27	0	5	92

- International Bandwidth: 1 --> 27
- Population: 1.8 / 0.2
- Technology: 2%, 0.7%, 74
- Cables (0): No cables
- GNI: US$ 550
- Internet penetration: 4.8%

The Guinea Bissau registry is managed by the national telecom regulator – ARN (Autoridade Reguladora Nacional) in partnership with the Portuguese Associação DNS.PT, which is also responsible for managing the registry for the Portuguese ccTLD, .pt. There were no answers to the questionnaire from Guinea Bissau.

Although the IANA database has no URL for the registry, it was found that http://nic.gw goes to a well-designed landing page with both Portuguese and English language support. It appears that the administrators of the registry need to update the IANA Database with the correct Registry URL. The site is about two years old and is well documented. The landing page and technical back-end is run from Portugal (dns.pt) and runs EPP. It also offers both IDN and DNSSEC support, so is likely to also support IPv6.

There are 19 accredited registrars, and domain applications are also available directly, via a web front end. Web applications may take a number of days before a domain is delegated. Applications are accepted from anywhere in the world and domains are registered at the second level, although there is also a generic second level used by government (.gov.gw). In testing of the online domain registration application process, a number of the stipulated rules, such as providing a Citizen ID number, were not enforced.

Connectivity is quite limited in Guinea Bissau with a penetration of only 3% recorded in 2013, but this is likely to be higher today due to the recent availability of 3G broadband and competitive backhaul connections to neighbouring Senegal and Guinea (Conakry). Although low connectivity levels are likely to be a contributing factor, there is no immediately apparent reason why this ccTLD does not have more domains, especially considering the domain registration fee is relatively low, at USD $34. Google indexes a total of 208 000 web pages under the .GW domain, or 1 825 per domain.

One explanation could be due to the rules on domain names which indicate that it is only possible to have a domain name that matches the business name, trade mark or personal name. This would hinder many domain names from being registered. For example, in South Africa it was initially expected that the number of domains would be limited to about the same as the number of registered companies, however South African Breweries (SAB) has the sab.co.za domain but now also has domain names for each product - castle.co.za, amstel.co.za, etc. In practice many more domain names than company names are likely to be registered - people have come up with a wide variety of innovative names for many different reasons. However under the GW domain application rules, these and other generic or descriptive domains such as whitepages.gw would appear to be prohibited.

7.4.4 Guinea (GN) – 277 Domains

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
GN	6	18	4	10	8	27	0	15	88

- International Bandwidth: 4 --> 15
- Population: 6.3 / 1.2
- Technology: 2%, 2%, 73
- Cables (1): ACE
- GNI: US$ 470
- Internet penetration: 7.9%

The administration of the GN domain is the responsibility of the National Centre of Fisheries Sciences of Boussoura, while the technical support is provided by well-known Internet guru Randy Bush. There were no answers to the questionnaire from Guinea.

Domains are registered under the third level, with standard generic 2nd level domains of .GOV/.GOUV.GN, (unusually, they allow both) .COM.GN, .EDU.GN, .ORG.GN and .NET.GN. Applications are processed via email using a simple text form. Registrations must be from organisations with a real presence in the country and with a demonstrable intent to use the domain name on a regular basis, and, as per RFC 2182, it is required that at least one secondary nameserver is on a different international backbone than the primary server.

Guinea's Internet penetration is not dissimilar to other countries that have many more domains. However, the cost of registering a domain is high – over USD $140. This is almost double the African average and given the low income levels in the country, lack of hosting facilities and high cost of connectivity, is likely to be a major reason for the low number of domains registered, especially when the requirement for in-country presence by the domain holder is taken into account. Google indexes a total of 72 800 web pages under the .GN domain, or 263 per domain.

7.4.5 Chad (TD) – 234 Domains

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
TD	5	12	8	2	29	27	0	3	86

- International Bandwidth: 1 --> 9
- Population: 17.6 / 2.3
- Technology: 7%, 0.6%, 43
- Cables (0): Landlocked, There appears to be at least one fibre connection.[160]
- GNI: US$ 980
- Internet penetration: 3.3%

The Chad ccTLD is administered by the national regulatory authority - Office Tchadien de Régulation des Télécommunications (OTRT). There were no answers to the survey questionnaire from Chad. The URL provided in the IANA database is incorrectly stated as http://www.sotel.td (which does not function). The correct site is at http://nic.td and contains many useful elements, however much of it is still under construction.

Domains may be registered at the second level (*.td) and under 4 generic second level domains – .com.td, .net.td, tourism.td, and org.td. Registrations in each case cost almost USD $300.

[160] https://www.budde.com.au/Research/Chad-Telecoms-Mobile-and-Broadband-Statistics-and-Analyses

Chad is one of the poorest countries in the world: it is landlocked and is still developing its national and international backbone connectivity with Cameroon and Sudan. While these factors are undoubtedly part of the cause for the low number of domains registered, the major factor is likely to be the very high price for domain registration – almost four times the African average, and the highest on the continent. Google indexes a total of 317 000 web pages under the .TD domain, or 234 per domain.

7.4.6 Liberia (LR) – 303 Domains

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
LR	7	17	6	18	9	27	0	19	103

- International Bandwidth: 1 --> 6
- Population: 4.3 / 0.8
- Technology: 0.4%, 0.8%, 66
- Cables (1): ACE
- GNI: US$ 370
- Internet penetration: 9.2%

The official administrator of the Liberia ccTLD is a private company called Data Technology Solutions, while the technical contact and registration process is handled by Randy Bush, in a similar manner to the Guinea ccTLD. There were no answers to the questionnaire from Liberia and mail to the address listed in the IANA database for the administrative contact murey@liberia.net was returned undeliverable. As with Guinea, domain registrations require at least one secondary nameserver on a different international backbone than the primary server. In addition registrations must be from organisations with a real presence in Liberia and with a demonstrable intent to use the domain name on a regular basis on the Internet. Applications cost about USD $100 and are made via email on a simple text form. Domains can only be registered under the generic second level domains of COM.LR, GOV.LR, EDU.LR, ORG.LR and NET.LR.

Liberia is in the process of developing a new national ICT policy and associated regulations which includes plans to redelegate the ccTLD according to ICANN procedures, to an official government structure, most likely the national regulator – Liberia Telecommunications Authority (LTA). This process will include a multi-stakeholder consultation process and a drop in charges for domain

registration is expected, along with an agreed set of policies for the types of registrations that will be accepted[161].

Given the low level of communications infrastructure development in the country, which has suffered from decades of civil strife followed by the Ebola crisis, it is not particularly surprising how few domains have so far been registered under the ccTLD. Hopefully the recent efforts to improve local infrastructure, including plans for a metro fibre backbone, along with the new strategy for managing the domain, will improve prospects for registrations in future. Google indexes a total of 285 000 web pages under the .LR domain, or 941 per domain.

7.4.7 Niger (NE) – 409 Domains

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
NE	**8**	**16**	**14**	**5**	**10**	**27**	**0**	**2**	**82**

- International Bandwidth: 2 --> 16
- Population: 17.6 / 2.3
- Technology: 7%, 0.6%, 43
- Cables (0): Landlocked, Fibre connectivity is mentioned[162]
- GNI: US$ 410
- Internet penetration: 2.4%

The administration of the ccTLD is managed by Sonitel, the incumbent state-owned telecom operator. There was one registrant response to the questionnaire from Niger. The URL listed in the IANA database http://www.intnet.ne is a general hosting website that only gives the output of the phpinfo() function for the home page, and provides a few hosted pages for a variety of organisations unrelated to domain management. Nevertheless some international commercial registrars appear to have negotiated with Sonitel for domain sales at relatively high prices, ranging from USD $230 to as much as USD $412 / year. Domains may be registered under the top level for the same price as domains under five generic second level domains - com.ne, org.ne, info.ne, int.ne and perso.ne.

[161] http://a4ai.org/november-23-2016-a4ai-liberia-meeting-to-review-ict-policy-2017-2021/
[162] https://www.liptinfor.net/en/internet-services-niger/fibre-internet/

Similar to Chad, considering the high prices for domains, the low level of ICT infrastructure development and low income levels of the country, along with the lack of a functioning domestic registrar, it is not surprising that Niger has so few domains registered under the ccTLD. Hopefully with the government apparently planning development of a national backbone and a more competitive market[163], the situation will improve if pricing for domains can be dropped. Google indexes a total of 364 000 web pages under the .NE domain, or 890 per domain.

7.4.8 Benin (BJ) – 734 Domains

CC	ccTLD Domains	gTLD Domains	Webpages	Price	Local Hosting	Registrars	IXPs - FoM	Penetration	Total
BJ	**9**	**37**	**11**	**22**	**11**	**27**	**36**	**21**	**174**

- International Bandwidth: 14 --> 58
- Population: 10.9 / 2
- Technology: 10%, 0.6%, 85
- Cables (2): ACE, GLO-1
- GNI: US$ 890
- Internet penetration: 11.5%

The Benin ccTLD is managed by the incumbent state-owned fixed line operator Benin Telecoms. There was one reseller response to the questionnaire from Benin. However, there was little useful information provided by the responder. The URL provided by IANA http://www.nic.bj/ goes to a login page which states (in French only) that the site is undergoing maintenance. There is no further information on the page, but a functioning WHOIS server, which is active at http://whois.nic.bj, was found via Google search. This page also lists a URL for registrations and policy information at http://www.coccaregistry.org, however this New Zealand site is non-functional.

Domains are all registered at the second level directly under the .BJ ccTLD, except for government agencies, which are registered under gouv.bj. The lowest domain registration fee offered by international registrars is USD $82.

Compared to the other countries discussed here, Benin has relatively more ICT infrastructure (including a recently commissioned IXP) and a consequently high level of Internet penetration.

[163] Unpublished on-going research for ECOWAS by a Study member

This is the likely cause for the slightly higher number of domain registrations in the country, and it is likely that this would increase significantly if prices for registration were dropped and the registry site made functional. Google indexes a total of 360 000 web pages under the .BJ domain, or 490 per domain.

Overall it can be seen that the countries discussed in section 7.4 suffer from a combination of factors that have led to low levels of in-country domain registrations. In summary the key factors are:

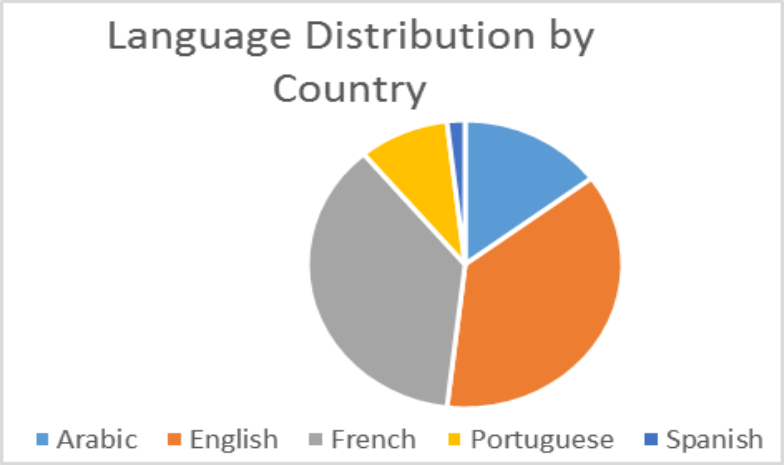
- High fees for registering a domain;
- Rules that restrict domain registrations to entities with a legal presence in the country, or only names that match the business or personal name;
- Non-functioning registry landing pages;
- Manual procedures for registration fulfilment and payment;
- Lack of marketing and critical mass of credible domain users;
- Low levels of local broadband infrastructure development;
- Low general income levels of the population.
- Lack of demand drivers such as e-commerce and e-government.
- Lack of an enabling regulatory framework

7.5 Regional & Language Results

7.5.1 ccTLD Domains

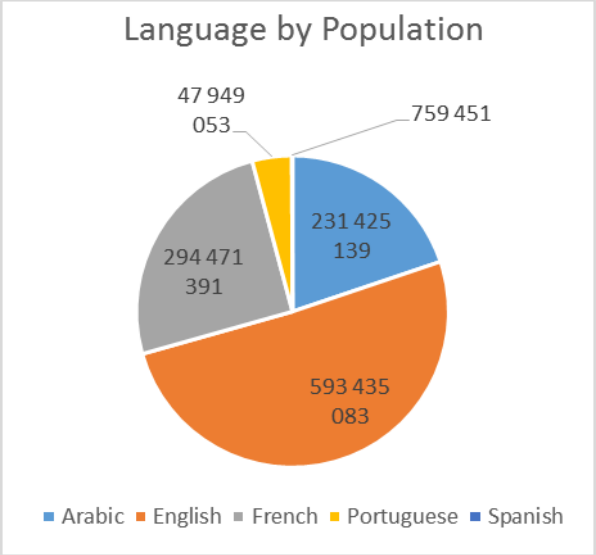
The analysis of the African DNS Market by region and by official language was initiated with an examination of how many African countries use each of the four primary languages: Arabic, English, French and Portuguese (Equatorial Guinea uses Spanish, but also uses French and Portuguese). As can be seen, equal numbers (20) of countries have English and French as their primary colonial language, followed by Arabic (8), Portuguese (5) and Spanish (1).

Figure 7-2: Language Distribution by Country



In terms of population, 51% of the population has English as their official language, followed by French at 25%, Arabic at 20%, then Portuguese at 4%, with a negligible number for Spanish.

Figure 7-3: Language by Population



Looking at the regions, the largest is West Africa with 18 countries and 31% of the population. This is closely followed by North Africa, with 11 countries and 30% of the population. East Africa comes in with five countries and 14% of the population, followed by Southern Africa with 10 countries and 13% of the population.

Figure 7-4: Countries by Region

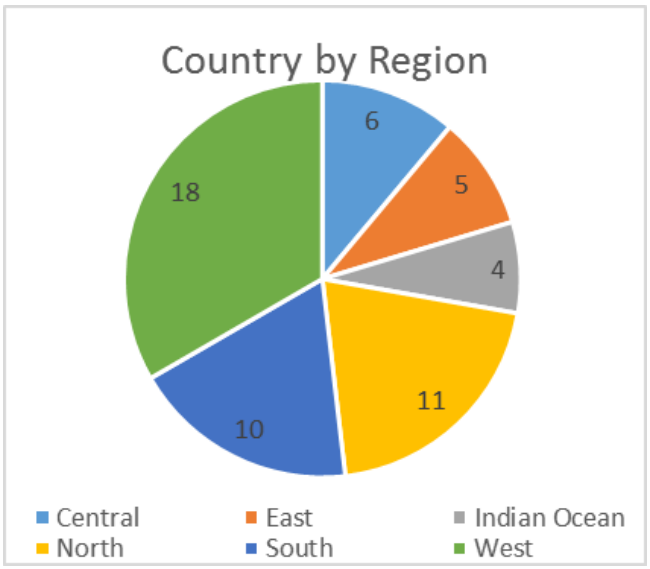
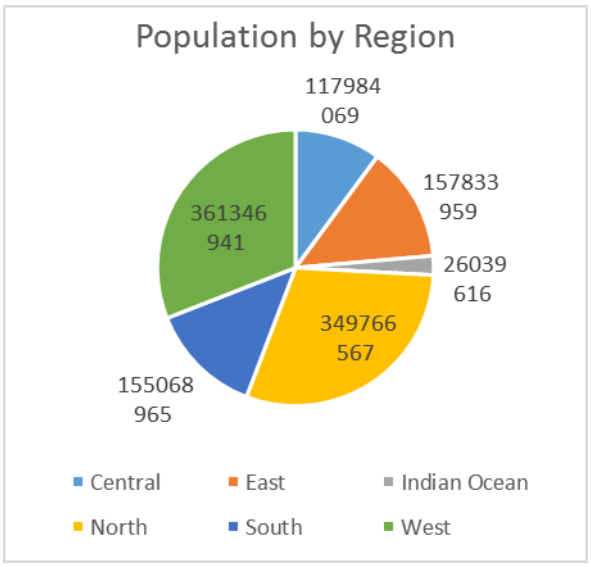
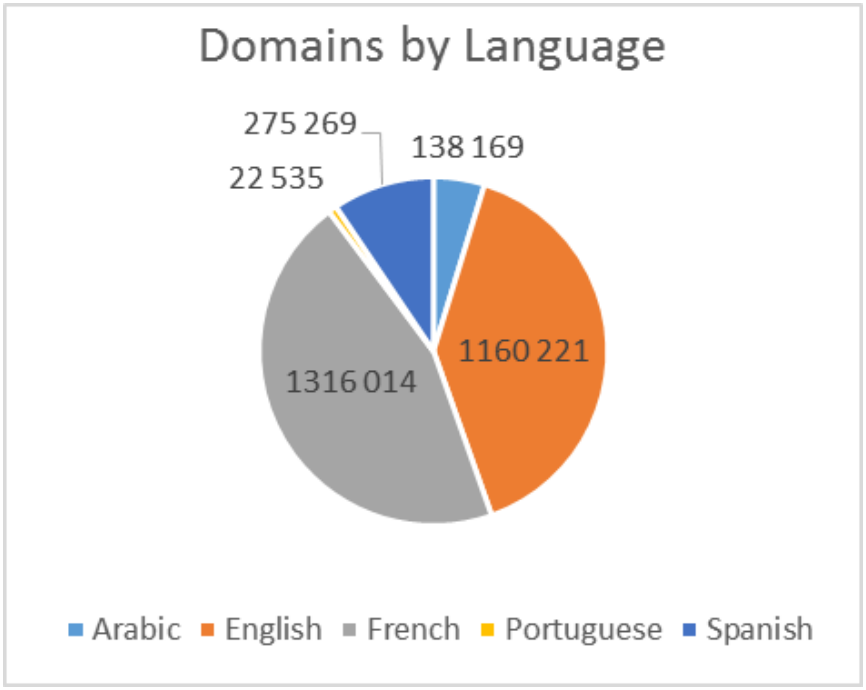


Figure 7-5: Population by Region



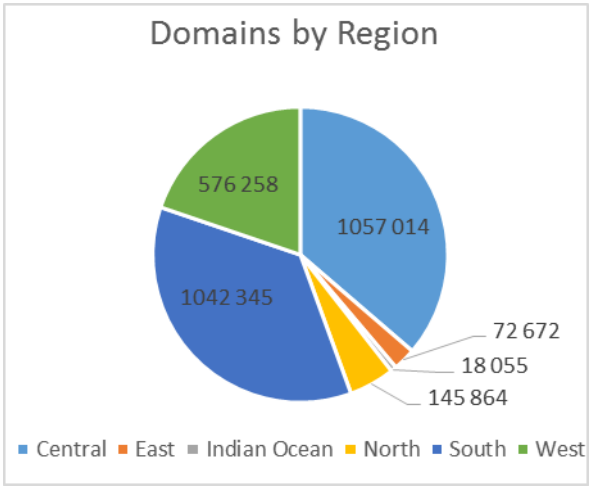
Analysis of the Study results shows that 45% of all African ccTLD domains analysed accrue to French speaking countries, closely followed by English with 40%. Spanish comes next with 9%, followed by Arabic with 5% and Portuguese trailing with only 1%. The reason for the apparent popularity of Spanish domains is no doubt the "domain hack" for the .GQ domain

Figure 7-6: Domains by Language



On a regional basis, Central and Southern Africa lead with 36% of ccTLD domains registered each, followed by West Africa at 20% and North Africa at 14%.

Figure 7-7: Domains by Region



More meaningful, perhaps, are the statistics of the number of domains registered per capita in each language group, excluding the four Freenom countries: -

Figure 7-8: Domains by Language, Normalised

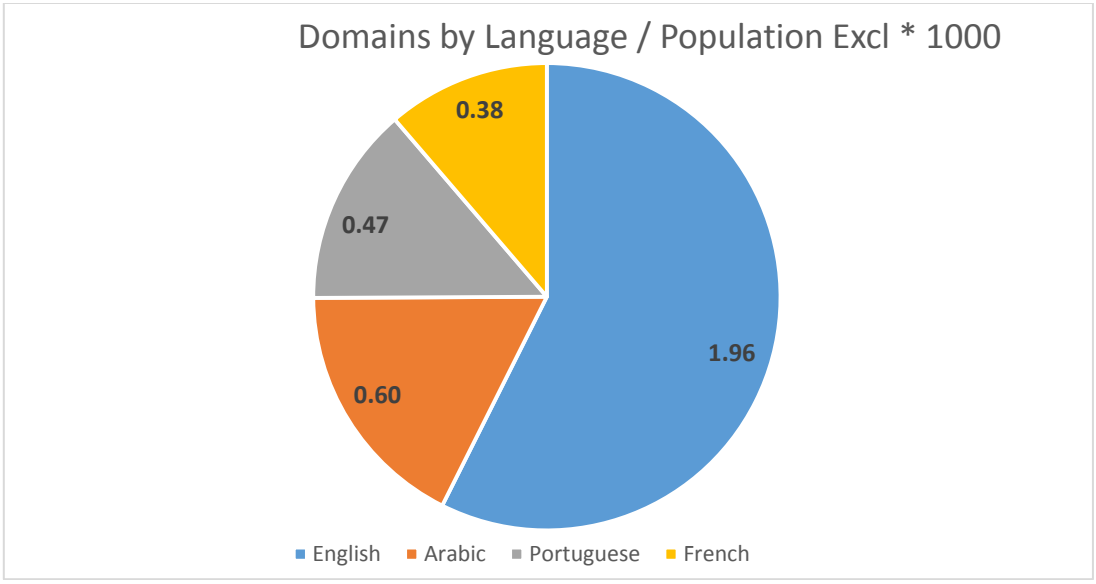
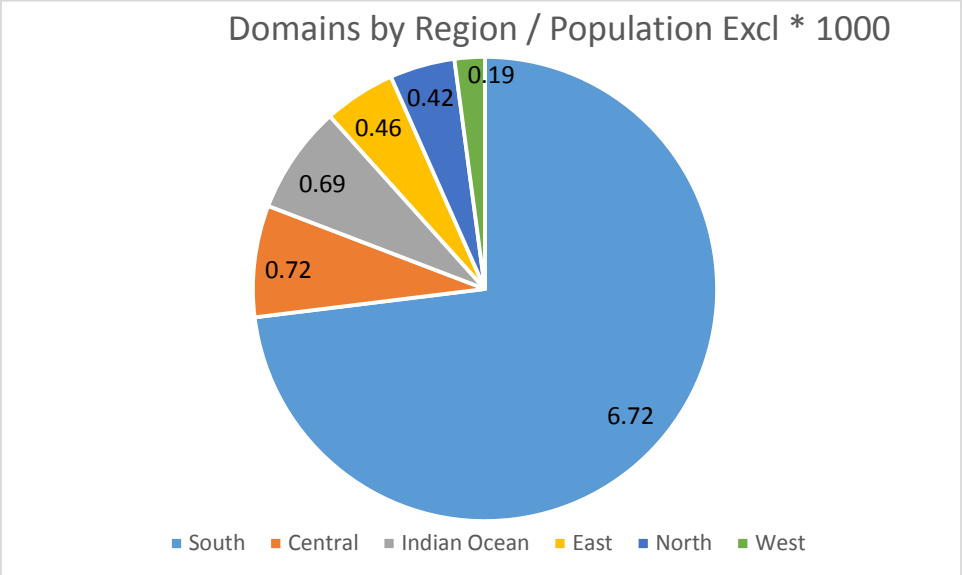


Figure 7-9: Domains by Region, Normalised



From the charts above, it is very clear that English and Southern Africa dominate in both of these per capita measures, largely due to the influence of South Africa holding about 1/3 of all ccTLD domain names in Africa.

7.5.2 gTLD Domains

In addition to the ccTLD data discussed above, the slightly over one million gTLD domains identified by Afilias and EyeDomain were also analysed. Every domain was checked for the existence of a website, and if so, of a substantial website (i.e. more than just a placeholder). A number of parameters of each domain were analysed and recorded, including the language indicated by the HTML tags within the websites found. Only about 20% of the domains had a "real" website with a valid Language Tag, and it would appear that quite a few of those were in error, with a number of single websites having strange languages specified, such as Haitian Creole (ht) or Welsh (cy). Interestingly, 104 were tagged as Thai (th) and 98 as Vietnamese (vi), for example.

Table 7-4: gTLD Websites with Language Tag

DESCRIPTION	DOMAINS	%
Total gTLD Domains	1 134 926	
Total websites	709 989	63%
"Real" websites	342 813	30%
With Language Tag	229 330	20%

A total of 229 330 websites with apparently valid Language Tags were identified. These covered a total of 115 languages, of which 23 can be considered "African". Excluding six "colonial" languages, that leaves websites in 17 indigenous African languages. These research results are indicated in the following graphics.

Figure 7-10: gTLD Website Language Distribution

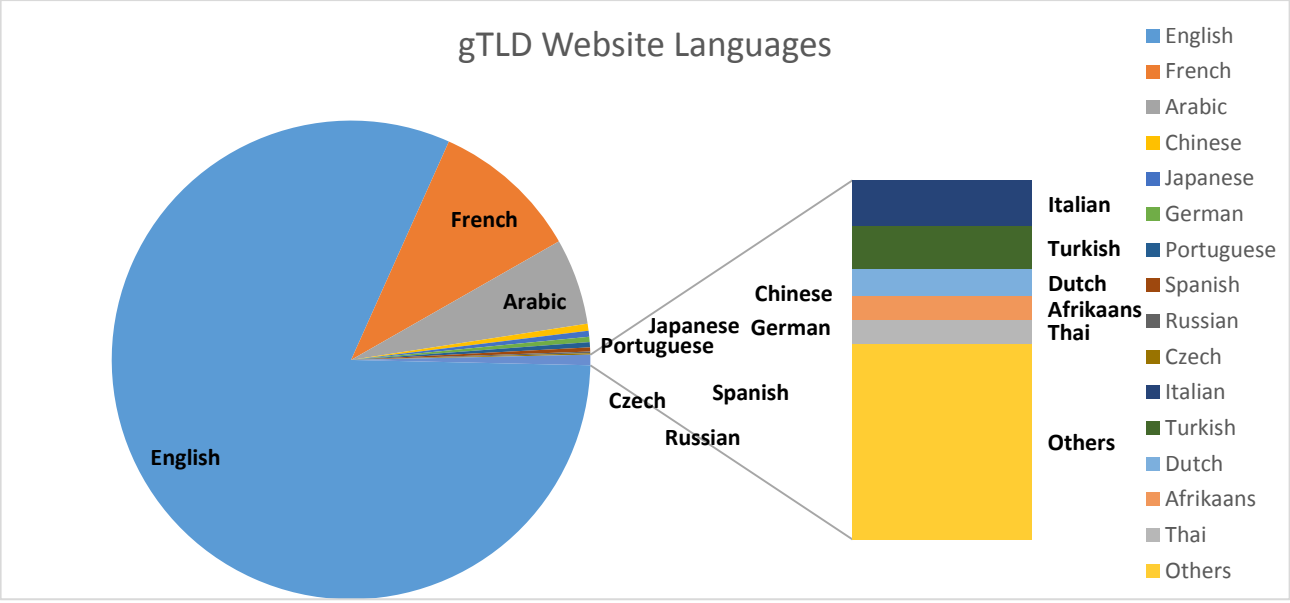
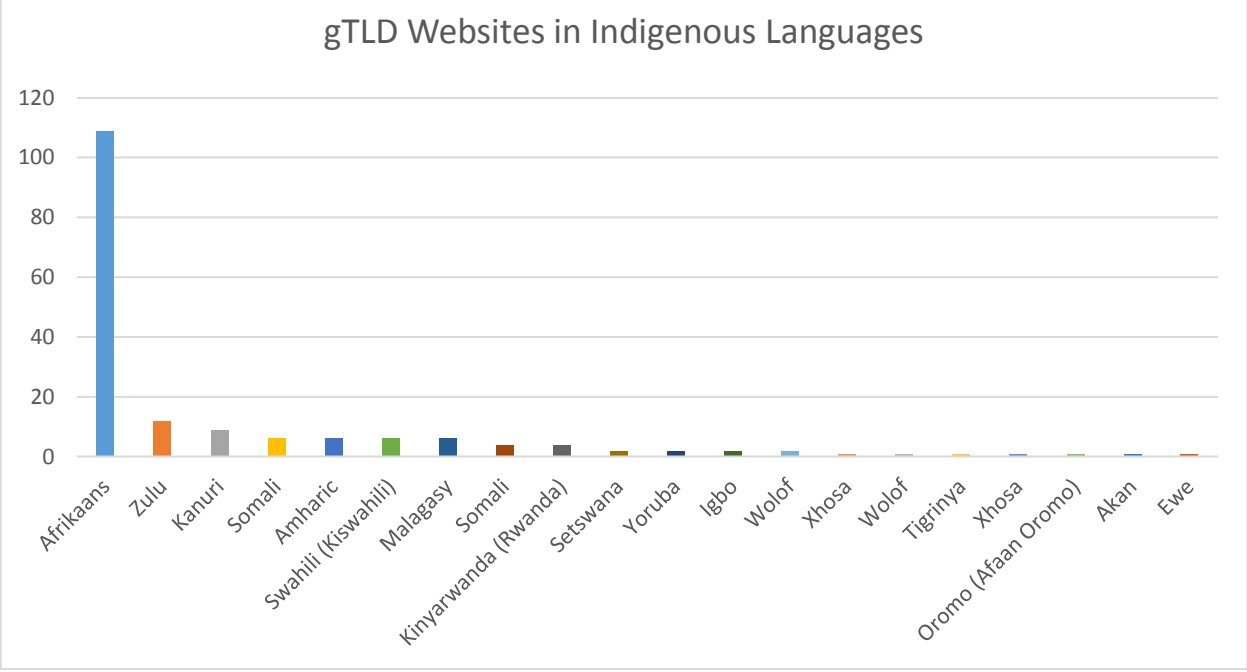
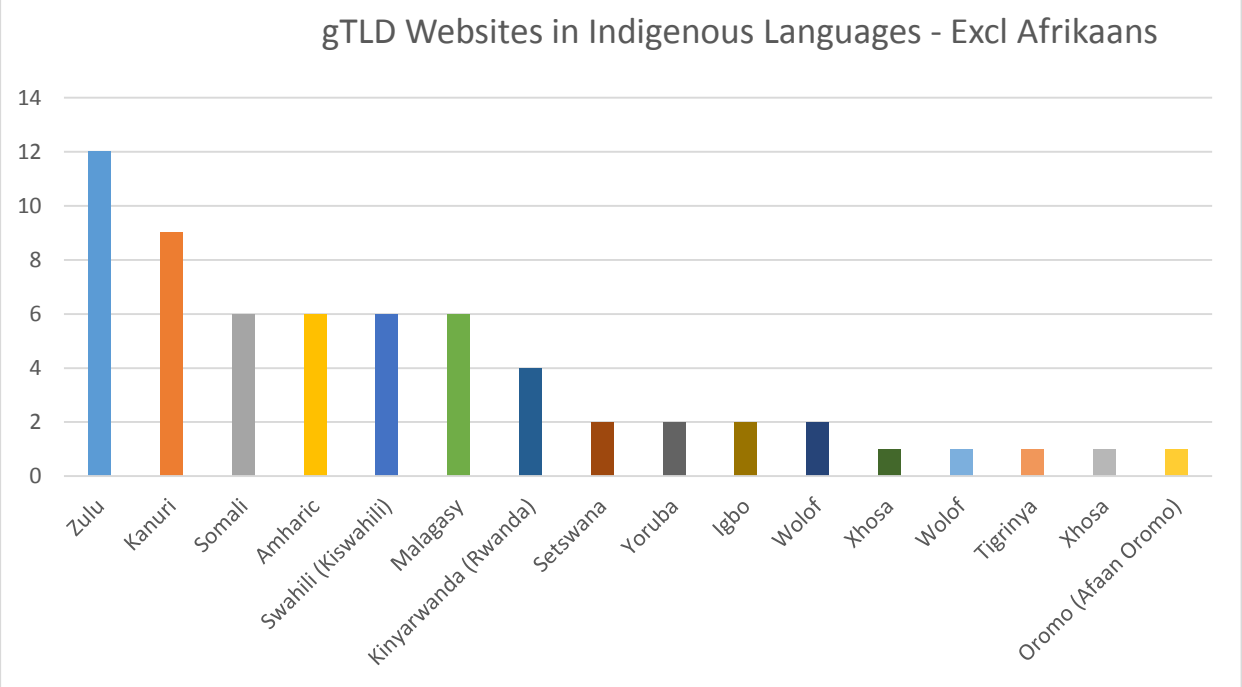


Figure 7-11: gTLD Website Indigenous Language Distribution



As Afrikaans makes up 62% of these indigenous language websites, the following graphic excludes Afrikaans:

Figure 7-12: gTLD Website Indigenous Language Distribution – excluding Afrikaans



It is clear from these gTLD website results that Africa still has a long way to go in terms of creating content for its citizens in the languages spoken by its people.

8 KEY SUCCESS FACTORS – REGISTRIES & REGISTRARS

Limited empirical research has been conducted worldwide into critical success factors impacting on the uptake of DNS registrations and the growth of the DNS markets.

Selamat[164] looked at critical factors influencing the registration of Domain Names in Malaysia, and identified four not very helpful clusters of issues: technical issues (such as the Registry / Registrar system, Internationalised Domain Names (IDNs), the transition to IPv6 and more); DNS marketing; availability of DNS services; and, additional factors (ranging from population growth to culture).

The discussion of Pope and his associates[165], looking at the future of the DNS system, identifies a range of challenges. Their discussion looks at: technical issues, security concerns, structural arrangements, political considerations, governance matters and commercial issues.

Arabas and his colleagues[166] attempted to model demand for Domain Names in the Polish environment in order to guide DNS marketing strategies and to forecast demand, finding both weekly and seasonal cycles within an overall environment of exponential growth.

None of these analyses is particularly helpful as a practical guide to Registries. The lack of comprehensive research and analysis suggests the need for more empirical work in this area, to identify a clear set of critical factors that can form the basis of international best practice and guide the Registries and Registrars within national jurisdictions going forward.

As we have seen, Africa is a highly diverse region, with DNS markets ranging from the highly developed, highly sophisticated and very dynamic at one end of the spectrum to the most rudimentary at the other. It is also a challenging environment economically and in development terms, with much poverty and instability, but with growing prospects for growth and political stability. The African DNS market remains very small, with a mere 4.5 domains per 1000 people, compared with more than 100 in most other regions of the world. Yet this market is growing fast in some places.

In the context of Africa, on the basis of the preceding discussion in this report a number of key issues can be identified for engagement and action by Registries.

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[164] Selamat, H (2014) 'Critical Factors and Comparative Analysis that Influencing the Registration of Domain Name', *International Journal of Digital Information and Wireless Communications*, Vol 4 No 1

[165] Pope, M, Warkentin, M, Mutchler, L, & Luo, X (2012) 'The Domain Name System—Past, Present, and Future', *Communications of the Association for Information Systems*, Vol 30, No 1

[166] Arabas, P, Jaskóła, P, Kamola, M & Karpowicz, M (2012) 'Analysis and modelling of domain registration process], *Journal of Telecommunications and Information Technology*

8.1 Pricing

It is clear from the analysis elsewhere in this report that high prices for Domain Name registrations are an inhibitor in the uptake of local Domain Names. The burgeoning of FreeNom registrations is clearly due to the fact that they are free. Similarly, despite a clear preference by users for local suppliers and local Domain Names, the fact that these sometimes cost fees that are many multiples of international Domain Names prices is clearly also an inhibitor. The fact that the average cost to register a Domain in Africa is $84, compared to about $10 for a .COM domain speaks for itself.

High prices for domain names are a clear inhibitor

Here the solution lies directly in the hands of the Registries and the Registrars. Reducing pricing for DNS registration to align with international tariffs is clearly going to be compensated for by a greatly increased uptake for local Domain Names - the countries with the highest revenue have the lowest (non-zero) prices.

8.2 Payment Gateways

The analysis of responses to questions regarding the user experience of the DNS ecosystem indicates an overwhelming preference (78% of Registrants) for electronic payment channels (bank transfers, credit or debit cards, mobile money and PayPal). Respondents also ranked the absence of easy payment methods as one of the key barriers to growth in the DNS market.

Again the solution lies directly in the hands of the Registries and the Registrars. Properly functioning payment gateways need to be put in place to ensure easy payment of fees, which will in turn facilitate the uptake of local Domain Names.

8.3 Easy-to-use Registration Systems

As we saw, just over a third of Registrants responding to the user experience section of the questionnaire were able to describe their registration experience as "intuitive, automated [and] user-friendly". Similarly, respondents listed slow processing time as the third biggest challenge to development of the DNS market, and quality of technical support as the fifth most significant difficulty.

Once again the solution lies directly in the hands of the Registries and the Registrars. Ensuring that the systems and processes required to register Domain Names are readily accessible, simple, easy to use, as well as robust and efficient may require some investment of time, money and person-power. But it is likely to be repaid in the growth of the local DNS market and in greater uptake of local Domain Names.

8.4 Provision of Information

Another inhibiting factor in the development of the local DNS market is the lack of ready access to information, in their local language of preference, by Registrants regarding the choice of Domain Names available to them, and the process to be followed to register their choice of Domain Name, along with cost and turnaround time.

Registries and Registrars need, therefore, to ensure that all the information (including contact details and pricing) necessary to enable Domain registration is readily and clearly available, in all local languages, and via a variety of channels. Active marketing is likely to be helpful in this regard.

8.5 ZACR Case Study

8.5.1 About ZACR

The ZA Central Registry NPC (ZACR)[167] is the largest registry operator in Africa with a solid two-decade history of domain name administration and management services. There are currently over one million domain names registered in the CO.ZA second level domain name space alone. Over the past few years, ZACR has prioritised expanding internal institutional capacity while implementing world-leading business methodologies. The latter include long-term partnerships with the best available technical talent. In particular, ZACR has expanded its South African footprint by assuming the registry function for the following three unmoderated 2LDs in addition to CO.ZA: WEB.ZA, NET.ZA and ORG.ZA. This effectively saw the organisation embracing its original function as the Central Registry for the majority of 2LDs[168] within the .ZA ccTLD space. Key to ZACR's continued success in registration numbers is the now bedded-down city domains of .JOBURG, .CAPETOWN and .DURBAN.

8.5.2 Key Early Successes

One of the early success factors of ZACR was early automation of its processes and systems. This allowed for ease of access to domain name products, improved quality of service and delivered consistent solutions that built trust and loyalty among domain name users. In June 1992 bksinc.co.za became the first domain to be registered under .CO.ZA which had been delegated to UniForum SA to run. By 1994, when South Africa became a democratic country, a mere 450 .CO.ZA domain names were in existence. Today, ZACR, (a name change from "UniForum SA" to

[167] https://www.registry.net.za/
[168] ALT.ZA, NOM.ZA, EDU.ZA, GOV.ZA, AC.ZA, MIL.ZA and LAW.ZA are managed by others, but each has less than 1,000 domains.

better reflect its responsibilities), has continued to build an efficient Central Registry that administers over 1.1 million domain names, over 95% of which fall under .CO.ZA.

A key factor that has contributed to ZACR being the largest and most successful registry in Africa is that it never received government subsidies of any kind. In fact, the reverse is true: ZACR has sponsored government officials to attend ICANN and AfriNIC meetings to enable them to learn more about the domain name industry. ZACR has over the years been instrumental in supporting the South African and greater African domain name industry through skills development initiatives and smart corporate social investment initiatives[169].

8.5.3 ZACR Domain Count

Table 8-1: ZACR domain count: 1,122,375 (as of 21st Jan 2017)

Namespace		Total Domains	Percentage of Total
1	CO.ZA	1,076,254	95.891%
2	ORG.ZA	32,560	2.901%
3	.CAPETOWN	4,561	0.406%
4	.JOBURG	3,344	0.298%
5	.DURBAN	2,419	0.216%
6	WEB.ZA	1,805	0.161%
7	NET.ZA	1,432	0.128%

As can be seen, the .CO.ZA domain dominates the .ZA ccTLD, largely as a result of its early automation and its simple rules and processes for registration of domains. In 2014, the organisation also assumed responsibility for managing the registry function for the following three City TLDs: .CAPETOWN, .DURBAN and .JOBURG. These were a result of the second initiative by ICANN to increase the number of gTLDs available. This issue has been a long time in the genesis, and the subject was raised at the second IGF meeting in 2007, for example[170]. A related gTLD is .AFRICA, which was the subject of a long-running dispute, which was only finalised in February 2017. As of June 2017, over 900 "sunrise" domains have been registered under the .AFRICA gTLD.

[169] E.g. https://www.fid.org.za/about-us/our-partners/43-coza-cares-foundation
[170] http://www.intgovforum.org/multilingual/

From 2005 to 2015, the ZACR/UniForum S.A. gave free training on DNS to about 500 local participants. There were two courses, the "DNS Intro Course" and the "DNS Advanced Course" (which included DNSSEC). They were both given every six months, the Intro course followed by the Advanced Course. Courses were presented in Johannesburg and Cape Town. If the Intro Course was in Johannesburg in the first half of the year, then the Intro would be in Cape Town in the second half of the year.

Table 8-2: Key Success Factors for ZACR

Key Success Factors	
Policy certainty	ZACR enforces policies that ensure users are protected. This has resulted in increased confidence in the business and its products, which ultimately leads to increased use of South African domain names. Users are confident that disputes will be resolved speedily and unnecessary conflict will be eliminated. Consulting the market is at the forefront of ZACR's policy formulation processes. Both local and international industry players are consulted to ensure that the organisation benchmarks itself against best international practices.
Pricing	The domain name pricing in South Africa is very competitive in relation to other countries and registries. There is a concerted effort to keep the wholesale price affordable for all and this has contributed to the growth of the domain name space in the country.
Market access	It has always been quick and easy to register a CO.ZA 2LD domain name. With the move to the 3R model with multiple registrars providing a competitive registration environment, registering a domain name is even easier and more convenient. Currently ZACR has over 450 registrars primarily in South Africa but also in many other countries.
Strong technical competence	ZACR's EPP Registry system is based on open standards and incorporates current world best practices and has been further enhanced to cater to the needs of the ZACR stakeholders. The organisation prides itself in having strong, reliable, safe and secure technological infrastructure that has resulted in increased trust levels from the Internet community.
Political freedom	The ZACR is not a government entity and the model followed in the management of the domain name business is that of Registry, Registrar and Registrant. The Regulator (zaDNA) is a new player to the South African domain name industry due to the political importance of the ZA national identifier. The Electronic Communications and Transactions (ECT) Act of 2002 established this regulator for the purpose of assuming responsibility for the .ZA domain name space. However, the ZACR is a separate independent entity. There is however collaboration between all industry players and government which embraces and encourages freedom of expression on the Internet. Government does not prescribe which services are provided on the Web, which technologies are used, or what kind of content will be available. The result has been an innovative and competitive environment for the domain name space.

Training	The ZACR has in the past trained network operators in the intricacies of the DNS system, which has resulted in an increase in skill levels and ultimately in the demand for domain names.
Marketing	The ZACR engages in use of social media, above the line and below the line marketing and advertising to promote uptake of DNS names it offers.

8.6 Summary of Best Practice Recommendations for Registries

Based on the research undertaken and confirmed by this Case Study, the following recommendations are made:

- Ensure that contact details at IANA are up to date and that the landing page URL is correct – which should ideally be https://www.nic.[ccTLD];
- Ensure that the information Registrants need is easily found from the Home Page;
- Have an information page on who the registrars are and how to become accredited;
- Run a 3R model;
- Run EPP Software, or software of a similar nature;
- Provide a WHOIS system;
- Allow payments to be made electronically, including by credit card;
- Allow international registrars and registrants;
- Keep the rules of registration simple – allow people to be creative with the names they choose;
- Keep to a simple pricing structure - don't discriminate against international registrants;
- DNSSEC Sign your ccTLD (and any second level Domains) – and allow customers to also add the appropriate DNSSEC records;
- Run everything dual stacked (IPv4 and IPv6) and support IPv6 glue records (as well as IPv4 glue records);
- Ensure that you have three to five Name Servers. One primary, usually on the ccTLD's premises and several secondary name servers, each on a different network and in a different geographic location. Consider using an Anycast DNS system for the secondary name servers to improve lookup speed, resilience and reliability. We suggest all three of the options below are used:
    - One from AfriNIC;
    - One from the ICANN DNS Observatory; and one from
    - One of the commercial providers.

9 GROWTH OUTLOOK

In calculating the growth of African domains, the Study made use of several sets of data: extracts of gTLD zone files where the Registrant had some African identifying data from either Afilias or EyeDomain; Zone files from four countries; and summary ccTLD totals from DomainTools. In the first three cases, domain names with creation dates were available. The DomainTools data is simply a snapshot of domain counts. We were fortunate enough to have two sets of these latter figures, one from November 2016 and one from May 2017, which allows us to estimate growth. There was a considerable increase in African ccTLD domains registered during this period. However, almost all of these came from the four Freenom countries, almost all of which are hosted outside Africa and therefore contribute very little to either the growth of the Internet industry in Africa or the GDPs of the countries involved.

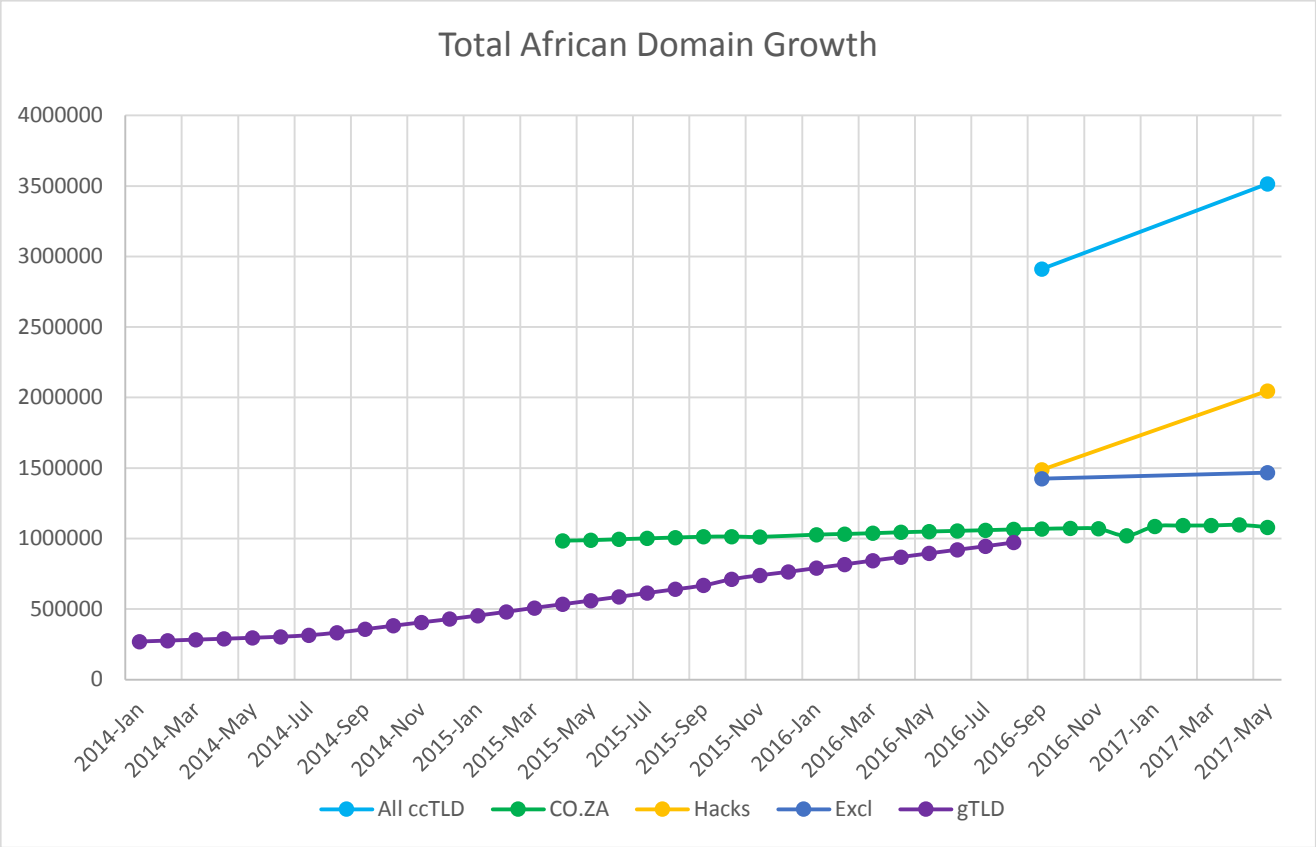
Total annualised growth is 33%

Annualised growth figures for the various categories of domain names are shown in the table below with the latest available total numbers, and the totals depicted graphically in the chart following.

Table 9-1: Annualised Domain Growth Rates

Category	All ccTLDs	CO.ZA	Hacks	ccTLDs Excl. Hacks	gTLDs
Total	3 514 833	1 080 375	2 047 369	1 467 464	972 406
Growth	31%	5%	56%	4.55%	52%

Figure 9-1: Domain Totals by Category

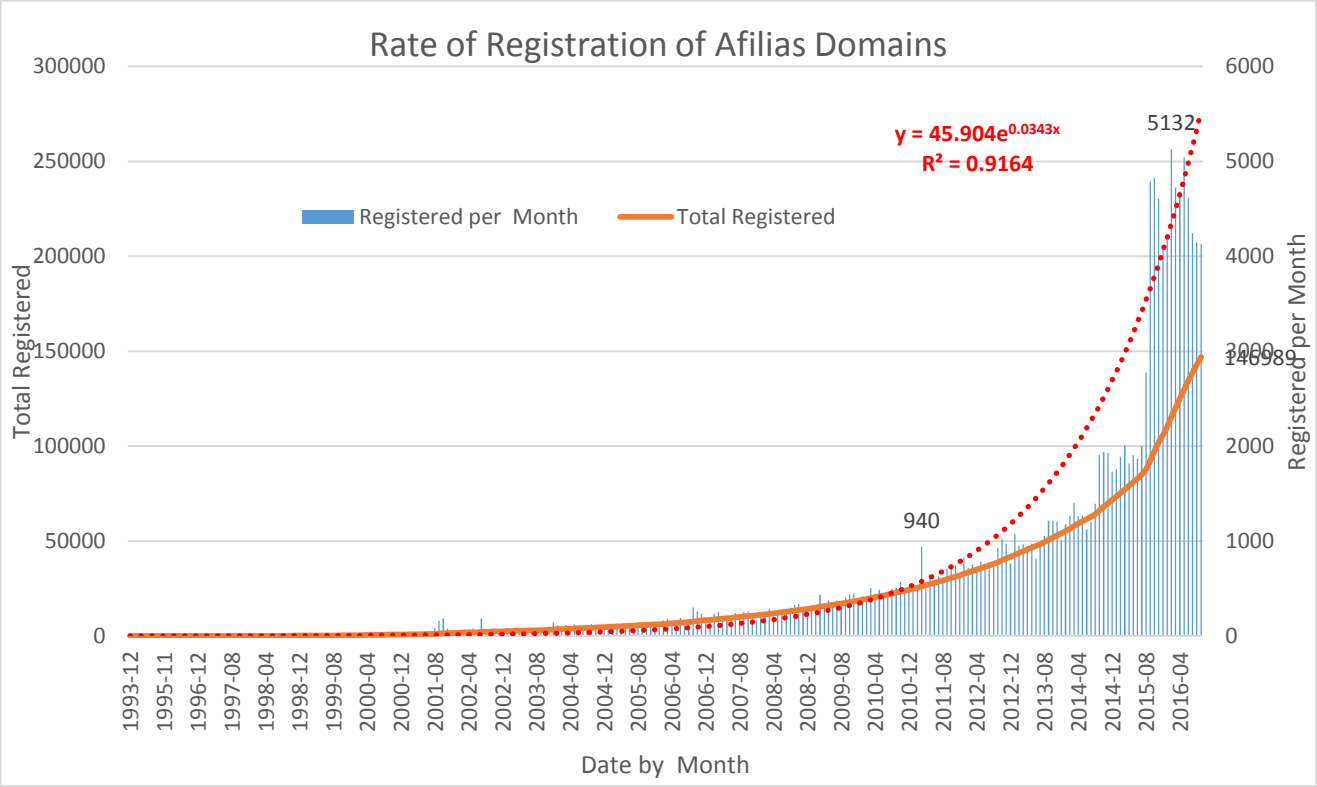


As can be seen in Figure 9-1, African gTLD domains will soon overtake .CO.ZA domains as the largest single category. The CO.ZA zone is the largest in Africa, and one of the oldest, with registrations dating from June 1992.[171] As a result, its growth has matured and become almost linear. It added a net 57,601 domains or about 5% in 2016, off a very high base. Future growth in CO.ZA may be linked to economic growth as well as increasing Internet uptake.

However, the growth in domain names generally in the African region seems to have accelerated significantly over the last few years. This is clearly illustrated by the figures for African registrations of Afilias gTLDs, below.

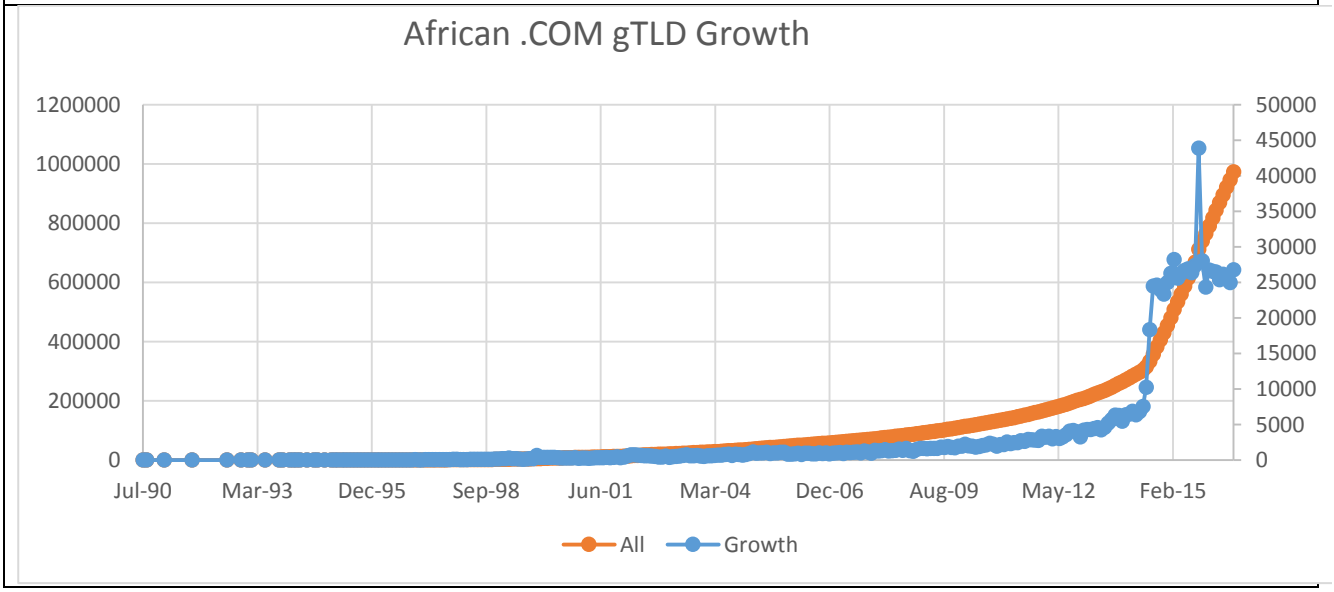
[171] https://www.registry.net.za/downloads/early_coza_registrations.txt

Figure 9-2: Rate of Registration of Afilias gTLDs



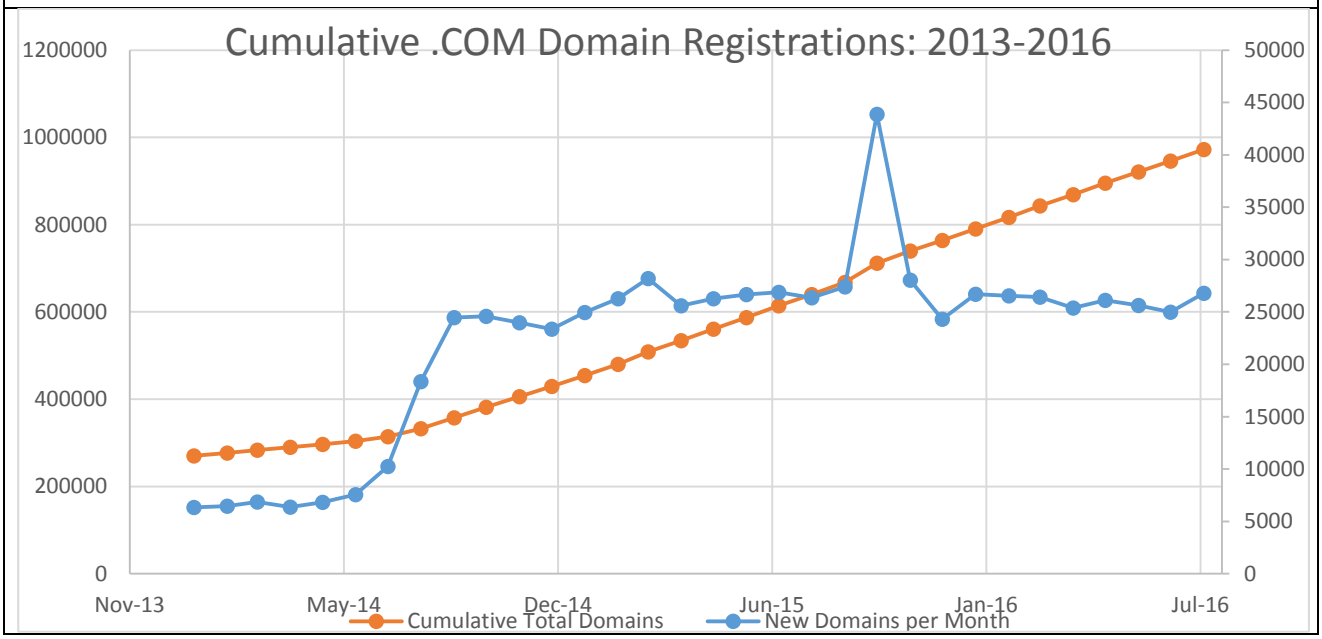
Similarly, there is a noticeable recent increase in the rate of growth in .COM domain names.

Figure 9-3: African .COM gTLD growth



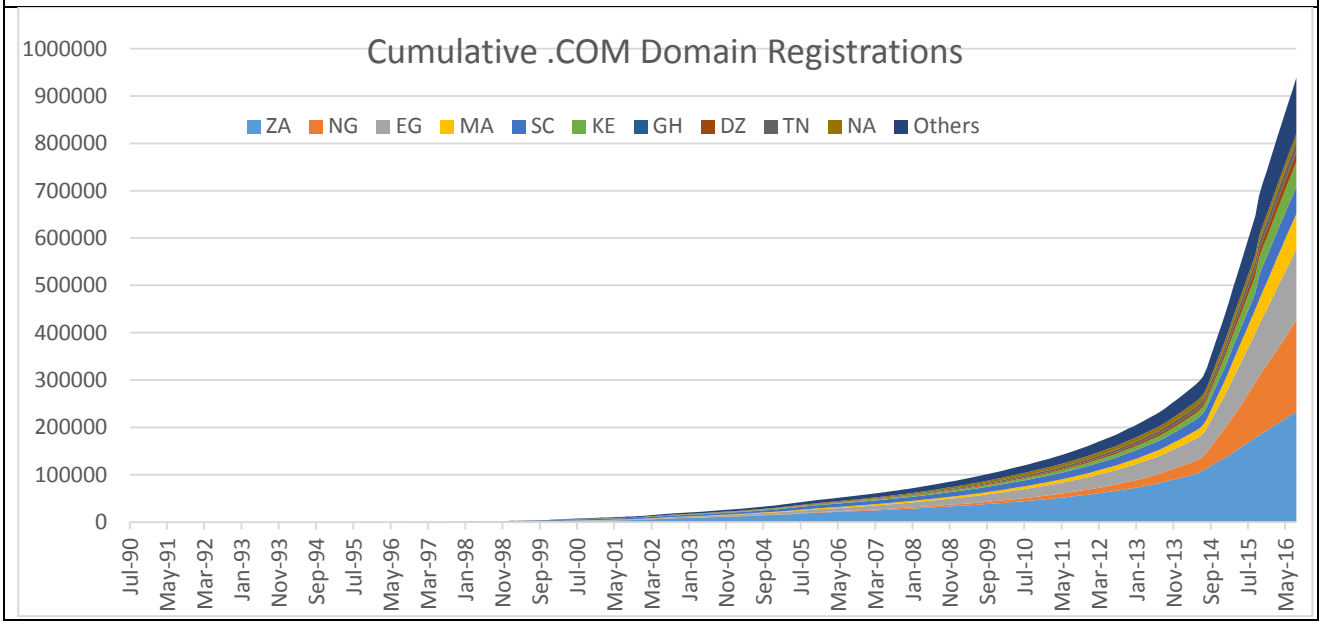
There is a clear step change in 2014. Further investigation indicates that this might be as a result of a change in data collection methods in 2014. Looking at this in more detail, we see that after September 2014 the rate of increase of .COM domains is fairly steady, with a slight upward trend, at about 27,000 domains added per month. This is shown in more detail here.

Figure 9-4: gTLD Domains 2013 - 2016



Finally, we show the growth in .COM registrations by the top ten African countries.

Figure 9-5: Top Ten .COM Countries



Aggregating the ccTLD and gTLD figures gives an average growth rate of 33% per annum in domain names. There is thus considerable market potential for domain name sales over the next three to five years in Africa. It is likely that the current very uneven Domain Name Market in Africa will continue for some time, until most countries reach suitable levels of Internet penetration, infrastructure and income levels. As this is likely to take some time – perhaps decades - some countries will still have their growth before them, while parts of the continent will be on the steep part of the "S" curve of growth, even when others have reached the growth plateau and are only growing at a rate constrained by GDP growth, as South Africa now is.

Other ccTLDs are growing at 4.5%

A note of caution: the headline figure of 33% growth in African domain names hides the perhaps more significant but far less impressive growth figure of less than 5% for other ccTLD domains.

10 Recommendation: Setting up a DNS observatory in Africa

As this report and the research process that underpinned it has shown, there is very limited data available on the DNS market in Africa. Recognising this, ICANN's 2014 Africa Strategy envisaged, inter alia, the establishment of an "observatory to develop new indices for DNS industry growth in Africa"[172]. The research project undertaken in this report is explicitly intended to underpin the setting up of an observatory that will continually monitor the growth, development and emerging needs of the DNS market in Africa.

The very nature of an African DNS market analysis, coupled with the challenges faced by the research team in compiling this baseline study, has meant that what is presented here is preliminary and partial. There are a number of reasons for this as set out below:

10.1.1 Access to qualitative data

Africa's 54 countries alone constitute a daunting challenge, complicated by its multi-lingual nature (at least five international languages - Arabic, English, French, Portuguese, Spanish - are used, along with some 1 500 local languages). As noted previously, responses to the comprehensive set of questionnaires developed for the qualitative component of the project were received from only 32 of the 54 countries. Long-term engagement and the development of relationships with a fuller range of stakeholders from a much more representative sample of countries are necessary to identify and understand the full spectrum of issues, trends and developments underpinning the DNS market.

10.1.2 Access to quantitative date

Access to domain zone files is essential for in-depth quantitative analysis of the DNS market, its current size and trends in relation to types of content, numbers of Domains, Registrars and Resellers. As noted previously, within the limited time for the research, the team was only able to access a very limited number of zone files from only a mere four of the 54 African Registries, almost all in Southern Africa (Lesotho, South Africa, Sudan, Zimbabwe), along with a limited number of Registrar database extracts, and supplemented by some international zone files. The ability to engage in structured, long-term formal institutional arrangements with a far greater number of Registries and Registrars across the continent is likely to result in a far more comprehensive set of quantitative data. This, in turn, will enable a far more accurate analysis of

[172] ICANN (2014) 'ICANN Africa Strategic Plan July 2016 – June 2020 Version 2.0', Internet Corporation for Assigned Names and Numbers, Los Angeles CA.

current phenomena and trends, along with a far greater ability to make medium to long-term forecasts.

10.1.3 Access to comparative research

The field of research into the DNS market is relatively in its infancy. Desktop research related to this study was only able to uncover a very limited number of expert and academic research reports relevant to the study and its objectives. Long-term engagement with academic institutions and entities working in the field is necessary to formulate an ongoing research agenda, covering at least the range of research questions addressed by the current research project. This will need to be supplemented by *ad hoc* bespoke research involving academics and consultants as the landscape changes and needs evolve and arise.

10.1.4 Case study data

The research team engaged in the current project had no access to any case study material on any of the 54 countries because very little exists, and were forced to write a number of mini case studies with limited resources and little cooperation from some of the key role players. The development of case studies, covering both 'successful' Registries and their markets, and those with limited scope and low levels of development, is essential to understand DNS markets in the African context and to identify remedial interventions designed to grow local markets.

10.1.5 DNS Observatory Mandate

The establishment of an African DNS Observatory has the potential to address and obviate a number of the research challenges identified above. Some of the functions of such a structural entity, housed on the continent, with limited but dedicated staffing and an earmarked budget, would include:

- Undertaking qualitative (online and face-to-face) surveys and interviews through engagement with the key stakeholders, from Registrants to policy-makers, in order to understand the user experience, and the factors and issues influencing DNS registration trends;
- Collecting, collating and analysing quantitative data from zone files and Registrar databases to measure and quantify the DNS market, at both national and regional levels, to track trends and make forecasts;
- Engaging with relevant academic and research entities to establish a research agenda relevant to the DNS market, and to collect and disseminate research reports, journal articles and the like of interest and relevance to the stakeholders in the DNS market;

- Undertaking, developing and sharing research case studies of DNS markets in the various African countries;
- Compiling and disseminating a database of research reports, research data and press reports, not only from Africa, but worldwide, of interest to the stakeholders in the African DNS environment and beyond;
- Publishing and circulating a regular newsletter, identifying, highlighting and sharing all of the above;
- Attending relevant meetings, conferences and stakeholder fora to make presentations and other contributions highlighting the research observatory agenda set out above.

10.1.6 Automating data collection

Minimising the human interface in the collection of quantitative data will both save costs and ensure that data provides real-time information. A DNS Observatory would need to establish a data collection server that allows ccTLD zone managers to configure automated real-time uploads and transfers of zone data. After the data has been collected, it can be analysed according to requirements, both on an ongoing basis for the production of quarterly, etc., reports, and periodically as needed. Once populated with the relevant ccTLD nameserver information, data collection would require very little maintenance while automatically generating up-to-date data, graphs and tables showing the development of the DNS market on the continent.

The automated data collection mechanism can be implemented by using the DNS Zone Transfer features of BIND (or other similar) software. All ISPs, and others, run such software in order to provide Primary and Secondary Name Servers. Secondary Name Servers must be on different physical and logical networks to the primary and to each other. A version of this system already runs on the **dnsafrica.study** server. This can act as an additional Secondary Name Server to African ccTLDs, which allows ccTLD Administrators to log in on https://secdns.dnsafrica.study and add their credentials and Primary Name Server details. They can then add their domains at their leisure. Zone Transfers can be protected by using the optional "TSIG" Transactional Signalling system. This system already includes a few African ccTLD zones and a working snapshot of this software for this purpose can be provided.

In more detail, the DNS Observatory quantitative data functionality would include:

- ccTLD owners receive credentials that allow them to add their domains to the system;
- Domain data is automatically updated whenever there is a zone change;
- The analysis software updates its database periodically – initially more frequently for new domains (once a week), then perhaps once a month;

- The ccTLD registry can examine trends and growth via the Web portal on demand, which would include data on:
    - Total number of Domains;
    - Domains with Websites;
    - Where Websites are hosted;
    - Language flagged by websites;
    - How many Websites have:
        - IPv6 addresses;
        - DNSSEC;
        - HTTPS;
- The data can be displayed as a current snapshot or plotted as a time trend for analysis;
- Data for public consumption can be extracted as and when necessary, which could include the summaries of the above, suitably anonymised and aggregated.

10.1.7 Obtaining ccTLD Registry Buy-in

Considering that it has already proved difficult to obtain copies of zone files, some sort of *quid pro quo* should be considered to encourage ccTLD Managers to allow their zones to be collected by the collector system. The most appropriate reward mechanism would be for the Collector to also potentially become an official Secondary Name Server for the ccTLDs, and perhaps in time, even an Anycast instance with locations around the African continent or even the world, or perhaps linked to the AfriNIC Anycast project.

Further to this, the system could be linked to the Zone Analysis software that the Study team has been using so that the ccTLD owners could be given detailed reports on their own growth and other appropriate statistics, such as what percentage of domains have websites, whether they are locally hosted or not, etc.

Some generalised data – perhaps updated monthly or quarterly, could be provided via a web interface to any other interested party.

Thus, this sub-project would be a longish term project with a minimum term of five years – probably extending indefinitely in the event that the project runs as an Anycast system.

In conclusion, buy-in would be achieved by:

- Providing Secondary Name Services free of charge;
- Providing Data Analysis on various aspects of value to the ccTLD Managers;
- Growing the System into an Any Cast service.

To create a single instance of an Anycast service, the Observatory would need the following:

- Its own IPv4 address space (/24) – free from AfriNIC (once off);
- Its own IPv6 address space (/48) – free from AfriNIC (once of);
- Its own ASN – free from AfriNIC (once off);
- Appropriately configured Server for Hosting;
    - Dual Gigabit Ethernet (Peering and Management);
    - 32 GB RAM;
    - Two separate 1 TB mirrored Hard Drive sub systems (or better);
    - Intel i7 CPU;
- Location at a suitable location – e.g. a major Internet Exchange Point in Africa;
- Local Peering (for the Anycast);
- Internet Connectivity (Transit) for Management and Website.

10.1.8 Institutional Arrangements

Institutional arrangements governing the establishment of a DNS Observatory are outside the purview and mandate of this report, and would need to be considered and agreed to by the relevant stakeholders at the appropriate forum.

Issues for consideration would include:

- The process for the establishment of the DNS Observatory, including time frames, and whether this should be by appointment, subject to competitive tender, or by some other process;
- Staffing and budget for the DNS Observatory for the first five years;
- Location of the DNS Observatory, possibly under AfriNIC, or housed under one of the Registries on the continent;
- Language(s) of communication, possibly Arabic, English and French;
- Funding arrangements for the DNS Observatory, including start-up funding, and ongoing funding arrangements and fund-raising plans; and
- Funding for outreach, such as ICANN / AfriNIC / AfPIF / AfTLD / AIS and SAFNOG meetings.

10.1.9 DNS Observatory Recommendation

- ➢ It is recommended that ICANN supports the establishment of an African DNS Observatory;

- It is recommended that the mandate of the African DNS Observatory include, as outlined above: qualitative and quantitative research; engagement with other DNS research entities; collection and dissemination of research reports, press reports and data, including by means of a regular newsletter; stakeholder engagement at relevant fora;
- It is recommended that a full proposal for the establishment of an African DNS Observatory be drafted, approved by ICANN and tabled at the appropriate stakeholder forum.

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions and Recommendations from the Study

11.1.1 Findings: Understanding Africa's Internet Ecosystem

Africa is a highly diverse region, with widely varying income and literacy levels, varied languages and cultures, and differing levels of development and infrastructure deployment. It is lagging in Internet access, with Africa having an average of 28.9% Internet penetration whereas the rest of world averages 54.2%. Between African countries, Internet access varies considerably, from 1% to 60% penetration.

The cost of access in Africa is very high

The cost of access in Africa is also very high. The average African pays 15% of his monthly income, versus 1% for the average European[173]. Adding in the fact that African Internet access is primarily via mobile devices, this results in a low demand for domain names because there are far fewer producers of content.

In the first decade of the 21st century, the mantra "Africa Rising" became popular. However, the 2008-2009 financial crisis reduced Africa's prospects due to a substantial decline in demand for raw materials, which is still a primary source of foreign exchange in many African countries. "African Rising" became "Aspiring Africa". While growth levels are not as high as they were, they are nevertheless still very attractive. Some of the relevant metrics are: -

- Internet penetration grew from 11% to 29% in five years;
- Smartphones doubled to 226 million over the last two years;
- More than 2/3 of African countries had 10 or more years of uninterrupted growth;
- There are 314 Innovation Hubs in 42 African countries;
- 80 Tbps of international submarine capacity is installed.

Backbone fibre networks are gradually spreading across most African countries, and all coastal countries except Guinea Bissau and Eritrea have submarine fibre. There is over 1 million km of terrestrial fibre installed, and cross-border fibre is increasing so that almost all countries will be connected to their neighbours by fibre by 2018.

Nevertheless, local access remains problematic in almost all African countries. Outside of South Africa, major deployments of metro fibre have largely been seen only in a few capital cities so far,

[173] http://a4ai.org/affordability-report/report/2015/

particularly Accra, Dar es Salaam, Kigali, Harare, Kampala, Lomé, Lusaka and Nairobi. Wi-Fi deployments follow a similar distribution, often preceding FTTH. However, even in these cities the majority of people use mobile access, which is very expensive in most parts of Africa and still limited to the major urban areas. Some municipalities finance free Wi-Fi.

Local Internet infrastructure to support hosting is improving, with 36 fully operational IXPs in 26 countries and an increasing number of fully-fledged data centres being built. However, in terms of IP resources, Africa only accounts for 2% of IPv4 and 1% of IPv6 addresses out of the total global usage.

A number of African (and other) countries have recently engaged in switching off access to the Internet during elections or other times of potential or actual protest against government. This trend is very costly to the economy of those countries and undermines trust in use of local Internet infrastructure for hosting content.

Analysing the volumes of web page content as indexed by Google shows that 75% of 400 million indexed pages is in just seven African countries. While specific analysis of e-government initiatives in Africa was not covered in this research, the study recognises that such services have been a crucial means in many countries across the world to increase local content on the web and to ensure content is relevant and available in users' language of preference.

The research further notes the potential for growth in the e-commerce market in Africa – in particular in relation to small, medium and micro enterprises. Currently, use of e-commerce by SMEs in Africa remains low. The current share of consumer e-commerce by African enterprises, for example, is currently below 2%, but has 'enormous potential' estimates Intracen[174], which says that by 2018, the African e-commerce market is projected to reach USD $50 billion, from just USD $8 billion in 2013.

11.1.2 The African DNS Market

A total of 51 functioning ccTLD Registries were identified during the course of the study. Only South Sudan (SS) is not yet delegated. Eritrea (ET) and the Comoros (KM), which each have just over 100 domains, have no apparent method of registering new domains via the Internet, and so are deemed non-functional. In terms of the Registrar Market, 26 countries have only one Registrar (usually the Registry itself), whereas 13 countries have a fully competitive Registrar market, with the remaining 14 countries being partly competitive and using older technology, and as indicated

[174] http://www.intracen.org/uploadedFiles/intracenorg/Content/Publications/International%20ECommerce%20in%20Africa_Low-res.pdf

above, Southern Sudan is not yet delegated. This was a factor in the number of ccTLD domains sold, although it is also true that successful markets seem to attract more Registrars.

For the Registrant Market, over 3.7 million African ccTLD domains were identified, plus some 1.4 million gTLD domains with an African Registrant. This equates to some 4.4 domains / 1000 population, whereas some commentators have observed that 100 – 300 domains / 1000 population is the norm in Europe. Nevertheless, despite its small size relative to other regions, this is still a valuable market, bringing in an estimated total value of USD $38 million per annum for African ccTLD domain names alone, and a total of USD $52 million per annum is spent when the gTLDs are included.

Research indicates that approximately 1% of gTLD domains are registered by Africans. Registration of (especially local) domain names fosters the growth of the economy in terms of the construction of data centres to accommodate the servers hosting African websites, the IXPs to interchange local data, the telecommunications (especially fibre) infrastructure to interconnect these locations, and, of course, the need for skilled people to design, implement, manage and maintain these infrastructure elements.

11.1.3 Key Success Factors for ccTLD Registries

The findings from our research identified a number of Key Success Factors for ccTLD Registries. These include:

- Affordable infrastructure which facilitates reliable access to the Internet is in place;
- There is widespread digital awareness among the population, and the public is aware of the value of the Internet;
- Citizens have sufficient literacy – both conventional and digital;
- Conducive policy, regulatory and governance frameworks are in place which create the necessary enabling environment to foster growth in the Internet sector;
- Payment gateways are in place to ensure easy electronic payment of fees. Responses to the online survey confirmed the need for easy payment mechanisms with both registrars and registrants indicating they preferred paying by bank transfer than by credit/debit card. Respondents also ranked the absence of easy payment methods as one of the key barriers to growth in the DNS market;
- Fees for registering a domain are cost based (though not zero);
- Registration is comparatively easy to complete (including simple automated systems in place for registration, and fast payment mechanisms available). Respondents to the

user experience section of the questionnaire cited slow processing time as the third biggest challenge to development of the DNS market and quality of technical support as the fifth most significant difficulty;

- Information on how to register a domain is easily available, promoting confidence and helping to facilitate a critical mass of domain names that fosters general awareness of the domain;
- Training of industry players in the technical aspects of good DNS management and implementation takes place regularly;
- An effective business model and a marketing / consumer awareness strategy is in place.
- No manual intellectual property rights evaluation prior to registering a domain. It is far cheaper and easier to resolve the few cases that will occur afterwards using an ADR mechanism;
- The Registry has a website with functioning and easy to use registry landing pages including simple and automatic procedures for registration fulfilment and payment, and payment by credit card as an option;
- The rules governing who may register a domain and how this is carried out are as simple as possible. For example, rules must not require domain registrants to have a legal presence in the country; nor should rules require domain names to match the business or personal name.

11.2 Recommendations

The two key recommendations based on the success factors identified above are:

1. There is a strong need to simplify, automate and expedite domain registration processes.
2. Many countries need to lower the cost of ccTLD registration - the average registration cost is $84 for an African ccTLD domain compared to about $10 for a .COM domain. It is noteworthy that the countries with the highest revenue have the lowest (non-zero) prices.

11.2.1 Recommendations: Wider Environment

Some success factors apply to the wider enabling environment for growth of the Internet sector and ICTs more generally. Firstly and most obviously, Internet access constraints must be addressed. The issues here are not only cost, but also availability and performance within each country, and indeed connectivity between countries. These may be addressed by: -

- stimulating rollout of fixed and mobile infrastructure;
- encouraging LTE / 4G / FTTx deployment;
- encouraging PC uptake;
- reduce prices especially for data;
- supporting deployment of undersea cables, cross-border-fibre and domestic backbones.

Reduce costs by market liberalisation and interconnection via local IXPs

In addition, these should be supported by the following actions -

- Initiatives to build digital literacy;
- Initiatives to facilitate e-government and assist countries in moving government services online should be supported. This would include a range of digital services, for example, promotion of e-learning and e-health;
- Similarly, specific strategies to implement and invest in building e-commerce across Africa should be developed – with a specific focus on developing strategies to facilitate an increased presence on the Internet by African SMEs and to facilitate innovative initiatives to promote e-commerce among this sector;
- Countries should focus on ensuring that it is easy to do business in the region.

Those countries without sufficient local hosting facilities need to build IXPs[175], data centres and metro fibre networks. It is important to note that the degree of success of an IXP is contextual - dependant on an enabling and supportive environment. An allied point is that cross-border fibre is vital to all.

Unless there is sufficient local content – by which we mean content that is not only locally written but that is relevant to citizens and is available in the languages of their choice - Internet penetration will not take off dramatically, nor will local hosting and interchange of content by data centres and IXPs boom. An important demand driver for this is governments committing to deployment of e-government - online delivery of services. This will increase their accessibility and substantially reduce costs for both government and citizens. Finally, governments should ensure freedom of expression online as it encourages content creation and acts as an industry driver.

Governments should aim for on-line delivery of all e-government services

- A concerted effort also needs to be made to address impediments in relation to terms of policy, regulation and governance. Policy-making, regulatory and registry functions should

[175] Note especially that building an IXP is neither complicated nor expensive. The fundamental issue to be resolved is the willingness of network operators to interconnect with each other.

be separated where they are not and these entities should encourage participation by all stakeholders and, for example, recognise and engage with their national ISP Associations;
- Appropriate light handed regulatory and governance mechanisms;
- Sufficient Internet penetration;
- Sufficient Internet infrastructure.

11.2.2 Recommendations: Domain Name Market

The most important recommendations for the DNS market itself are:

- There should be cost-based (but not zero) fees for registering a domain;
- No manual intellectual property rights evaluation prior to registering a domain;
- ccTLDs should use the "3R" Model, i.e. separate roles for each of the Registry, Registrar and Registrant;
- Multiple registrars should be encouraged. Analysis shows that if there are sufficient number of Registrars - at least 20 – this ensures adequate competition;
- A simple, quick and cheap dispute resolution system – commonly called an 'Alternative Dispute Resolution' (ADR) – should be implemented and supported by appropriate legislation.

The Registry should have a website with functioning and easy to use registry landing pages. It should provide simple and automatic procedures for registration fulfilment and payment, and should include payment by credit card as an option.

There should be an effective business model and a marketing / consumer awareness strategy, with appropriate regulatory and governance mechanisms.

11.2.3 Basic Internet infrastructure improvement

There are a variety of areas that need to be addressed by the authorities in some countries in Africa. These are:

11.2.3.1 Poor Market Access and Network Provisioning Models

Among the most common reasons for limited infrastructure is the lack of competitive open markets and barriers to market entry for basic infrastructure providers, along with limited access to sufficient radio spectrum. Incumbent fixed-line national operators and a few mobile operators continue to dominate markets for broadband in many countries. This affects coverage, cost, and quality of services. Many governments continue to protect legacy fixed-line operators and existing mobile operators from new players wishing to use innovative technologies and business

models. Moreover, the 'new incumbents' – the mobile operators - are usually subsidiaries of large international companies and are able to use their superior resources to influence the regulatory environment so that it favours their investments in older technologies over potential new entrants. For example, in many cases licensing requirements and fees can be too onerous for smaller private operators and community-driven initiatives such as 'village fibre' or municipal Wi-Fi.

11.2.3.2 Inadequate Spectrum Management

One of most important issues in terms of expanding the market for domain names is increasing access to the Internet. Conservative spectrum assignment methods continue to restrict the potential for new providers looking to make use of the latest technologies. For example, fixed broadband operators can use new wireless systems such as TV white spaces (TVWS) and other dynamic spectrum-sharing approaches where regulation allows this.

11.2.3.3 Lack of Public Access Facilities

For people who cannot afford their own equipment and connectivity, or who only have access in their place of work, public access facilities could offer an effective alternative. However, there is limited investment in libraries, telecentres and multi-purpose community centres amenable to the provision of public Internet access. Support for the provision of public access has unfortunately fallen off the agenda in most countries as a result of the rapid growth of Internet-connected mobile phones, which has reinforced the widely-held view that public access is just a stepping stone to private access. Nevertheless Internet Cafés remain popular – and profitable – in a number of African countries.

In addition, some countries provide free Internet access at public schools.

12 Summary

The 2016 African Domain Name System Market Study examined the DNS market in all 54 African countries, including several Indian and Atlantic Ocean Islands. The objective was to identify strengths and weaknesses in the industry ecosystem within this highly diverse region and to develop recommendations on how to advance the industry.

The methodology included an online survey in four languages and analysis of Zone Files. Responses to the survey were received from 69 countries. However, 22 African countries provided no response at all. Zone files and Registrar database extracts were analysed and pertinent data obtained without doing WHOIS lookups, such as the presence and location of hosted websites and the languages used. In addition, extensive research was carried out on all 53 ccTLDs, their registries, Registrars and the numbers of domains registered.

A number of factors for each country were examined, including Internet penetration rates and the presence of functional IXPS. All 54 countries were ranked on a Country DNS Success Index. Detailed results are presented for 20 of the countries. A clear link was found between the presence of an established IXP and a lively Internet industry and high score in the Success Index.

We found that there are, as of May 2017, some 5.1 million domain names associated with Africa. This total is currently growing at 33%, although less than 5% of this growth is in ccTLD domains from countries other than the four Freenom 'domain hack' countries. The total annual value of the African Domain Name market is some $52 million.

Many countries could usefully remove or reduce barriers to growth of the Internet industry generally and the Domain Name market in particular.

Only one market, South Africa, may be regarded as "mature", in that its growth rate is linear and seems to be constrained by GDP growth. All other countries are either in the steep "growth phase" or have yet to reach this. There is thus considerable potential for growth in the Domain Name market in Africa for the foreseeable future.

13 ANNEXES

13.1 Table of Figures

13.2 Table of Tables

13.3 Glossary of Terms

2R Model	In order for a person (a Registrant, the second 'R') to acquire a Domain Name from a Registry (the first 'R') the Registrant purchases the Domain directly from the Registry.
3R Model	In order for a person (a Registrant, the third 'R') to acquire a Domain Name from a Registry (the first 'R') the Registrant purchases the Domain via a Registrar (the second 'R'), that is, there is a (usually accredited) middleman.
CIDR	Classless Inter-Domain Routing – a network prefix can fall on any bit boundary, as opposed to the older Class 'A', 'B' and 'C' networks.
IPv4	Internet Protocol version Four. The original 32 bit address given to a computer as a unique identifier, split up into 4 by 8 bits. It looks like 192.168.10.30 Any one part has the range from 0 to 255.
IPv6	Internet Protocol version Six. The much larger replacement for an IPv4 address, is 128 bits long and split into 8 parts each of 16 bits in length. Representation is in hexadecimal using the hex characters of 0-9 and A-F. Each part is from 0000 to FFFF (0-65536 in decimal). Around the world, we are on the last few remnants of IPv4 addresses.
IXP	When three or more organisations interconnect and exchange traffic with each other via a common switching fabric. Peering is often free - except perhaps to cover the shared infrastructure costs where the exchange of traffic actually happens. Usually, peering reduces transit time (things are faster) and improves quality of service.
Mean	The average value of a set of data.
Mode	The most common response or value within a set of data.
Network Prefix	The modern standard form of specification of the network prefix is CIDR notation, used for both IPv4 and IPv6. It counts the number of bits in the prefix and appends that number to the address after a slash (/) character separator: e.g. 192.168.0.0, netmask 255.255.255.0 is written as 192.168.0.0/24.
Peering	When two networks exchange data originating or terminating on their networks, or those of their customers. See also Transit.
Premium Domain Names	Not all domain names are created equal. If it is a short name (three or less letters) or a generic name (travel, green, diver), it can simply be worth more. If the Registry has no formal Premium Domain Name system, entrepreneurially inclined people may buy such names in the hope of reselling them at profit. If the Registry does run a Premium Domain Name service, then the names are sold more directly to the customer but at a Premium Price.
Punycode	Punycode is a special encoding used to convert Unicode characters to ASCII. See https://www.punycoder.com/
"Real" Website	In the study, when analysing the Domains in a Zone file, we queried whether the Domain pointed to a Website or not. However, the website could just be a place holder ("Website coming soon"). We

	thus define a Website as a "Real Website" if the first page is more than 2000 bytes (characters) long and has more than four links of some sort.
Registrant	The Registrant is the person who is the "owner" or rather the user of the name that is registered in the Registry Database. In most systems, Users "rent" the ability to use the name and if they fail to keep up the payments, they can lose the name, potentially to a different user.
Registrar	As there are more and more Registrants for a particular Registry, it becomes easier for the Registry to use an intermediary agent, the Registrar, to deal with the Registrants. Registrars can also be agents for multiple Registries which can make the Registrants life easier if he wishes to rent domains from a number of Registries, he can do so via one point of contact. Registrars are often legally bound by contract to the Registry, to act in a certain way such as levels of service.
Registry	The Registry operator is (usually) a natural monopoly. The Registry maintains the unique Database of Names that have been Registered (or acquired) along with the appropriate contact information for the domain names in the Database.
Reseller	A Reseller in the Domain Name supply chain sits just above the Registrant. He can often act like a Registrar but usually does not carry the Registrars' legal requirements. In "2R" models that migrate to "3R" models, the Reseller often becomes the Registrar.
Transit	When traffic leaves the local ISP, crosses over multiple other upstream Internet Providers and eventually reaches its destination, we call the intermediary networks "Transit Providers". There is almost always a cost involved. From an African prospective, this often means our traffic will be routed overseas via the USA and/or Europe before getting to its destination. Without Peering, this could be to the building across the road from you. Transit is thus often slow and expensive.
WHOIS	There are servers that when asked who owns a Domain Name, will reply with the contact details for that Domain. These are WHOIS servers. Other objects apart from Domain Names can also be queried, such as IP Addresses. See RFC 3912

13.4 Acronyms

2R Model	Registry and Registrant
3G	Third Generation
3R Model	Registry, Registrar and Registrant
4G	Fourth Generation
A4AI	Alliance for Affordable Internet
ADR	Alternative Dispute Resolution
ADSL	Asynchronous Digital Subscriber Line
AfriNIC	African Network Information Centre
AINC	Arabic Internet Names Consortium
AMU/UMA	Arab Maghreb Union
APC	Association for Progressive Communications
API	Application Program Interface
ASN	Autonomous System Number
ASWG	Africa Strategy Working Group
AU	African Union
AUC	African Union Commission
AXIS	African Internet Exchange System
BIND	Berkeley Internet Name Domain
CAGR	Compound Annual Growth Rate
ccTLD	Country Code Top Level Domain (e.g. 'KE' for Kenya, the country's two letter ISO Code)
CDN	Content Distribution Network
CDSI	Country DNS Success Index
CERT	Computer Emergency Response Team
COMESA	Common Market for Eastern and Southern Africa
CRASA	Communication Regulators Association of Southern Africa
DB	Data Base
DCR	Data Centre Research
DNS	Domain Name System
DNSSEC	Domain Name Security
DRC	Democratic Republic of Congo
DSL	Digital Subscriber Line
EAC	East African Community
EASSy	Eastern African Submarine Cable System
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
ECT	Electronic Communications and Transactions
EDGE	Enhanced Data for GSM Evolution
EPP	Extensible Provisioning Protocol
EUN	Egyptian Research and Education Network
FoM	Figure of Merit
FTTH	Fibre to the Home
FTTx	Fibre to all possible optical fibre topologies
Gbps	Gigabits per second, a transmission speed
GGC	Google Global Cache
GNI	Gross National Income
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
GSMA	Global System for Mobile communications Association
gTLD	Generic Top Level Domain (e.g. COM, ORG, NET, ...)

HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
IANA	Internet Assigned Numbers Authority
IAP	Internet Access Provider
ICANN	Internet Corporation for Assigned Names and Numbers
ICT	Information and Communications Technologies
IDN	Internationalised Domain Name
IGAD	Intergovernmental Authority on Development
IIAG	Ibrahim Index of African Governance
IMF	International Monetary Fund
INX	INternet eXchange
IP	Internet Protocol / Intellectual Property
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISOC	Internet Society
ISP	Internet Service Provider
ISPA	Internet Service Providers' Association
IT	Information Technology
ITU	International Telecommunications Union
IXP	Internet eXchange Point
KIXP	Kenyan Internet Exchange Point
kW	Kilo Watt - a measure of electrical power
LAC	Latin American and Caribbean countries
LIR	Local Internet Registry
MB	Mega Byte - a measurement of the amount of data (e.g. on a disk)
Mbps	Megabits per second, a transmission speed
MEAC	Middle East and Adjoining Countries
MS	Microsoft
MSN	Microsoft Network
MySQL	My Structured Query Language, an open source database
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organisation
NRA	National Regulatory Authorities
OECD	Organisation for Economic Co-operation and Development
PCH	Packet Clearing House
PHP	recursive acronym for PHP: Hypertext Pre-processor
PIDA	Programme for Infrastructure Development in Africa
PwC	Price Waterhouse Coopers
REC	Regional Economic Communities
RFC	Request for Comment
RIR	Regional Internet Registry
SAB	South African Breweries
SACF	South African Communications Forum
SADC	Southern African Development Community
SME	Small and Medium Enterprise
SSL	Secure Sockets Layer
SudREN	Sudan Research and Education Network
Tbps	Terabits per second, a transmission speed
TEAMS	The East African Marine System
TSIG	Transactional Signalling
TV	Television

TVWS	Television white space (the unused space between TV channels)
UK	United Kingdom
UNECA	United Nations Economic Commission for Africa
UNESCO	United Nations Educational, Scientific and Cultural Organization
URL	Uniform Resource Locator
US	United States
USA	United States of America
USC	University of Southern California
USD	United States Dollar
WACS	West Africa Cable System
Wi-Fi	Wireless Local Area Network
ZACR	South African Central Registry (renamed from UniForum SA)
zaDNA	ZA Domain Name Authority

13.5 ccTLD Country Codes

Country	ISO	ISO	Country
Algeria	DZ	AO	Angola
Angola	AO	BF	Burkina Faso
Benin	BJ	BI	Burundi
Botswana	BW	BJ	Benin
Burkina Faso	BF	BW	Botswana
Burundi	BI	CD	Democratic Rep of Congo
Cameroon	CM	CF	Central African Republic
Cape Verde	CV	CG	Congo
Central African Republic	CF	CI	Ivory Coast
Chad	TD	CM	Cameroon
Comoros	KM	CV	Cape Verde
Congo	CG	DJ	Djibouti
Democratic Rep of Congo	CD	DZ	Algeria
Djibouti	DJ	EG	Egypt
Egypt	EG	ER	Eritrea
Equatorial Guinea	GQ	ET	Ethiopia
Eritrea	ER	GA	Gabon
Ethiopia	ET	GH	Ghana
Gabon	GA	GM	Gambia
Gambia	GM	GN	Guinea
Ghana	GH	GQ	Equatorial Guinea
Guinea	GN	GW	Guinea-Bissau
Guinea-Bissau	GW	KE	Kenya
Ivory Coast	CI	KM	Comoros
Kenya	KE	LR	Liberia
Lesotho	LS	LS	Lesotho
Liberia	LR	LY	Libya
Libya	LY	MA	Morocco
Madagascar	MG	MG	Madagascar
Malawi	MW	ML	Mali
Mali	ML	MR	Mauritania
Mauritania	MR	MU	Mauritius
Mauritius	MU	MW	Malawi
Morocco	MA	MZ	Mozambique
Mozambique	MZ	NA	Namibia
Namibia	NA	NE	Niger
Niger	NE	NG	Nigeria
Nigeria	NG	RW	Rwanda
Rwanda	RW	SC	Seychelles
Sao Tome & Principe	ST	SD	Sudan
Senegal	SN	SL	Sierra Leone

Seychelles	SC	SN	Senegal
Sierra Leone	SL	SO	Somalia
Somalia	SO	SS	Southern Sudan
South Africa	ZA	ST	Sao Tome & Principe
Southern Sudan	SS	SZ	Swaziland
Sudan	SD	TD	Chad
Swaziland	SZ	TG	Togo
Tanzania	TZ	TN	Tunisia
Togo	TG	TZ	Tanzania
Tunisia	TN	UG	Uganda
Uganda	UG	ZA	South Africa
Zambia	ZM	ZM	Zambia
Zimbabwe	ZW	ZW	Zimbabwe

13.6 Study Team Members

The team for the study included:

- The South African Communications Forum (the SACF) is a prominent South African ICT industry association whose members include some of the leading stakeholders in the Telecommunication, Electronic Media, Postal, Information Technology, Electronic Manufacturing, Social Media and Broadcasting Industries who are active across the African continent. The SACF team included Loren Braithwaite Kabosha and other SACF staff members including Tom Tshitangano, Gabriel Ramokotjo, Peter Hlapolosa and Jethro Tshabalala
- William Stucke of William Stucke Associates, a niche telecommunications consultancy focusing on regulatory and spectrum issues. William is a long-standing campaigner for telecommunications liberalisation in Africa and is a former ISP and a former Regulator. He was Project Leader and Chief Editor.
- Mark Elkins of Posix Systems; one of South Africa's oldest ISPs. Mark wrote the original software that ran the .CO.ZA Registry for many years.
- Sami Salih of the Sudan University of Science and Technology;
- Anriette Esterhuysen and Mike Jensen of the Association for Progressive Communications' (APC), which has existing relationships with its many African member organisation and partners. Members of APC member organisations and partners were specifically contracted for this project. APC is a worldwide network of social activists who use the Internet to make the world a better place and an

organisation. APC has 50 organisation and over 20 individual members from 5 continents;

- Other prominent African Internet figures known to Team Members acted as Country leaders, such as Alex Corenthin (SN), Avis Momeni (CM), Baudoin Schombe (CD), Cade Zvavanjanja (ZW), Dotemin Konate (CI), Ernesto Alberto (AO), Grace Githaiga and Liz Orembo (KE), Gbenga Sesan (NG), Melaku Girma (ET) and Olévié Kouami (TG BF); and
- Additional authors and editors included Charley Lewis, Lesley Stones and Libby Lloyd.

The Study Team included native Arabic, English, French and Portuguese speakers.

13.7 Analysis by country/region:

- Breakdown of domain name registrations (including ccTLD versus gTLD registrations; registrations by business, governments, non-government, research and academic, individuals, etc.; percentage of active domains)
- Type of content hosted by these domains
- Share of the commercial sites that offer e-commerce services
- Whether this content is hosted within country or outside.

13.8 Methodological Observations

We relied on responses to questionnaires, analysis of Zone Files, interviews with relevant role players in the industry and desktop research. There were several mechanisms used to recruit respondents to the questionnaires. Firstly, some Team members attended various African Internet events during the course of the year, and took every opportunity to publicise the Survey at these events. In this, they were ably assisted by ICANN staff members, who also publicised the Survey. Secondly, a number of channels were used to publicise the Survey, including African mailing lists and a blog article on the AfriNIC website and mention in its newsletter. These two measures generated some 20% of the potential respondents (DB Users) who signed themselves up for the questionnaire.

For the balance of respondents, we recruited a Team of some 40 people, each of whom was assigned responsibility to identify and sign up suitable people from the countries for which they were responsible. Unfortunately, our results fell far below expectations. Our large team

identified, contacted and invited more than 1400 potential respondents (database users). Significant efforts were made to persuade users to complete their questionnaires, and a total of only 308 questionnaires were completed by 209 individuals in time for analysis.

13.9 Challenges

While there is a wide variation between the countries in Africa, as a whole the continent lags behind other regions in the use of the Internet and in the development of its local Internet industry. As a result, this sort of survey is significantly more difficult in Africa than in other regions. As this was the baseline survey, in many cases, role-players were not familiar with the concept of a market survey. The main challenges encountered were:

- Identifying sufficient suitable role players to be potential respondents;
- A lack of understanding of the value of outcomes of this survey to the respondents themselves;
- A misplaced emphasis on confidentiality of data on the part of some Registries and others, who seem to be unaware that their peers publish statistics that they consider "secret";
- A lack of trust, to the extent that several countries demanded specific letters of authorisation, over and above the original authorisation provided by ICANN;
- Keeping the number of questions down to a manageable number;
- Training of team members using electronic communication. Over 15 training sessions were held in total - this is an example of where funding for face to face training would have been useful;
- Insufficient funding and time for a project of this magnitude, especially in the African context, which presents distinctive challenges

Special thanks to all those people who took the trouble to read the full report and provide thoughtful and helpful comments, corrections and suggestions. Wherever possible, we have taken these into account and implemented the corrections and suggestions, and answered the questions within the text of this Final Report. However, quite a few points raised were outside the scope of this Study, which was of necessity limited. Many of them would be fertile ground for further research on the African Internet economy.

For whoever follows in our footsteps, we hope we have left you a comprehensive starting point from whence to continue this most interesting African journey.